THE HUMAN DIMENSIONS OF AQUATIC INVASIVE SPECIES MANAGEMENT IN TEXAS FRESHWATERS

A Dissertation

by

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ABSTRACT

Effective aquatic invasive species (AIS) management requires resource-users engage in mitigation behaviors that prevent unintentional AIS spread. As such, it is necessary to examine the behaviors users currently engage in, why they chose to do so or not, and how might natural resource managers influence users to engage is necessary behaviors. Informed by theories from social and environmental psychology, this dissertation examines normative social aspects of Texas boaters' AIS mitigation behaviors, i.e., perceived and actual social norms. Chapter II draws on the return potential framework to understand the relationship between boaters injunctive beliefs (beliefs concerning what should be done) and descriptive beliefs (beliefs concerning what is be done). Chapter III employs a quasi-experimental design to examine how different message frames affect boaters' intentions to engage in AIS mitigation behaviors. Chapter IV examines the belief-behavior process by asking how descriptive and injunctive beliefs and aspects of social comparison influence behavior. Collectively, findings from the three studies have implications for practice and theory. For theory, findings have direct implications for the plausibility of theoretical tenets related to normative social influence and the conditions under which normative social beliefs do or do not affect behavior. For practice, findings highlight influential variables that influence a boater's decision to engage in AIS mitigation, providing practitioners with insights to influence or facilitate behaviors that result in desired outcomes.

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1. INTRODUCTION

Natural resource management often relies on the behaviors of resource users to be effective and equitable. As such, it is necessary to examine how and why resources users engage in certain behaviors. This necessitates applied research that draws upon literature from social and environmental psychology (Gifford, 2014; Newell et al., 2014; McLeod et al., 2015). In addition to attitude- and value-behavior relationships, a popular approach to understand resource user behavior and decision-making in applied natural resource management settings is through examination of normative influences, particularly actual and perceived social norms (Schultz et al., 2008; Prentice & Miller, 2016). This stems from a theoretical foundation and a growing body of empirical literature showing that normative aspects of the social context in which people are embedded and make decisions significantly affects their behavior (Heberlein, 2012). More specifically, a perception of others' behavior or expectation of behavior can significantly influence one's own behavior. This perspective stems from an understanding that behavior is, more often than not, socially influenced.

Social norms refer to the informal rules of a particular social context with a level of consensus concerning typical or approved behavior, often enforced through social sanctioning mechanisms (Horne, 2009; Hetcher & Opp, 2001). Research on social norms, particularly normative social beliefs—the beliefs and mental representation of the social norm individuals hold—has highlighted their significant influence on behavior or intention (Miller & Prentice, 2016; Schultz et al., 2008). The past two decades have seen

an array of social norm research investigating social normative influences and behavior in natural resource context. While the body of theoretical and empirical literature continues to grow, questions remain as to how findings from social norm research, which have been studied in limited contexts, translates to other applied natural resource management contexts, particularly where the issues facing management agencies and necessary user behaviors are relatively novel.

Throughout the United States, invasives species are one of the most exigent issues facing natural resource management (McMichael & Bouma, 2000). Estimates put direct and indirect costs of invasive management in the United States between $120–143 billion, annually (Pimentel et al., 2005; U.S. Fish & Wildlife Service, 2012). Invasive species are defined as species that are non-native (or alien) to the ecosystem under consideration "whose introduction does or is likely to cause economic or environmental harm or harm to human health" (Executive Order No. 13,112, 1999, p. 6183). As such, invasive species continue to receive extensive research and policy attention (Genovesi & Shine, 2004; Lockwood et al., 2013).

Within inland freshwater systems, aquatic invasive species (AIS) threaten the diversity of native species, ecological stability, and the commercial, agricultural, and recreational activities dependent on such waters (Vander Zaden & Olden, 2008). The introduction and establishment of AIS often negatively affect economy, environment, and human health (McNeely, 2001; Pimentel et al., 2005; Ricciardi & MacIsaac, 2011). For example, AIS can negatively affect local economies by reducing recreational activities (boating and fishing) (Johnson et al., 2001), commercial activities (industrial

water uses and fisheries) (Lovell & Stone, 2005), and development interests (property value and housing markets) (Olden & Tamayo, 2014). Ecological effects can manifest as increased predation and competition, introduction of parasitism or pathogens, and significant habitat alteration (NOAA, 2014). Aquatic invasives also negatively affect human health through their role in contributing to, for example, algal blooms and disease outbreaks (Ricciardi & MacIsaac, 2011).

Primary sources of aquatic invasives into U.S. freshwaters include ballast water and the pet trade (US Commission on Ocean Policy, 2004). Limiting introduction and establishment of AIS is the most effective way to lessen their impact (Leung et al., 2002). Once introduced and established, preventing their continued spread then becomes priority. Within freshwater systems, once established, the management focus often shifts to boats and boaters, or similar water-based resource users, as the primary AIS vector (Anderson et al., 2015; Kelly et al., 2013; Vander Zanden & Olden, 2008). This focus follows from an understanding that (a) prevention is less expensive than control and (b) vessels and equipment are often unintentional vectors for AIS transportation between waterbodies that would otherwise be unconnected (Whitfield & Becker, 2014).

Recognizing the importance of the human dimensions of invasive species management has led to more human-centered approaches to effectively manage AIS (García-Llorente et al., 2008, Santo et al., 2015; Seekamp et al., 2016). This focus on the actions of resource users requires distinctly different policy and management, specifically those focused on understanding, influencing, and increasing mitigation behaviors (Hine et al., 2015; McLeod et al., 2015). Recent studies have employed a

human-centered approach to understand landowner perceptions, preferences, and support for invasive eradication and restoration programs (Santo et al., 2015), the factors leading live-bait anglers to release baitfish (Drake et al., 2015), and qualitative assessments of individual's conceptualization of and attitude towards invasive species (Selge et al., 2011). Recent projects in the Great Lakes region have assessed boater awareness of and behavior related to AIS (Lee et al., 2015; Connelly et al., 2014). These studies found primarily negative attitudes towards AIS but mixed results related to individuals' behaviors to mitigate the spread of AIS. Similar studies have echoed this variability, finding stakeholder attitudes are varied and complex, being partially influenced by experience with invasives (Ford-Thompson et al., 2015). Others have sought to determine factors that predict support for invasive species management practices. For example, Sharp et al. (2011) found attitude to be a significant predictor of AIS management support. However, the variability in attitude also manifested in management preferences; that is, more ecocentric attitudes preferred hands-off management while other, non-ecocentric attitudes preferred more hands-on management approaches (Sharp et al., 2011). Others have investigated the value orientation of resource users, instead of attitudes, and found those to be significant predictors of past and future AIS mitigation behavior (Pradhananga et al., 2015).

These and other studies have predominantly focused on boaters' knowledge, attitudes, and values, but few have explicitly linked behavior or intention to theory that accounts for normative social influences (McLeod et al., 2015). Relatedly, a considerable body of literature indicates a sole focus on raising awareness and education

is not necessarily an effective means to encourage behavior (Bell, 2005; Blake, 1999; Kollmuss & Agyeman, 2002; Schultz, 20011). Many boaters have not yet adopted mitigation behaviors (Rothlisberger et al., 2010) but express attitudes, values, and intentions that align with essential mitigation behaviors. Given these circumstances, boaters may require salient social influences, alongside education and awareness, to initiate behavior. Thus, AIS management may benefit from applying established behavioral theory ground in the social norm literature to understand how and why boaters engage in AIS mitigation behaviors.

In Texas, aquatic invasives species (AIS) are one of the most exigent issues facing natural resource management of freshwater systems. Species such as zebra mussel (*Dreissena polymorpha*), giant salvinia (*Salvinia molesta*), water hyacinth (*Eichornia crassipes*), water lettuce (*Pistia stratiotes*), and Bighead carp (*Hypophthalmichthys nobilis*) are a growing concern for natural resource management agencies in Texas (Parks & Wildlife Code § 66.0072, 2011). Exacerbating this concern in Texas are AIS within inland freshwaters frequented by resource users whose movement between waterbodies increases the potential for AIS to establish elsewhere (Vander Zaden & Olden, 2008). For instance, recreational boaters who travel to multiple waterbodies but fail to properly check and clean their boat or equipment for possible AIS create potential vectors for AIS (Anderson et al., 2015; Johnson et al., 2001; Kelly et al., 2013; Lee et al., 2015).

Currently, natural resource management agencies in Texas utilizes public awareness campaigns, i.e., the Clean, Drain, Dry ™ campaign (CDD), and boater

education courses to encourage AIS mitigation behaviors. The CDD aims to raise public awareness and promote the eponymous behaviors primarily by placing signs, billboards, and other messaging near public access points to waterbodies, at relevant businesses and vendors, or online. This doctoral dissertation employs survey research methods to examine licensed Texas boaters' perceptions and behaviors related to AIS and CDD, with a specific emphasis on understanding aspect of normative social influences that affect boater (in)action. This research adds to a growing body of environmental psychology literature and applied research focused on invasives species management. Insights from this research have implications for practice and theory. For theory, findings have direct implications for the plausibility of theoretical tenets normative social influence and examine the scope condition under which social norms affect or do not affect behavior. For practice, findings highlight influential variables and the process by which boaters choose to engage in AIS mitigation from a normative perspective, providing practitioners with potential methods to influence or facilitate behaviors that result in desired outcomes.

Three primary chapters structure the present research. In chapter II, I draw on the return potential framework (Jackson, 1966; Nolan, 2015) to understand licensed Texas boaters' perceptions of the traditionally measured injunctive social and extend this framework to account for individuals' perception of the descriptive social norm. Chapter III employs a quasi-experimental design to examine how normative social messages framed with descriptive or injunctive information affect Texas boaters' intended behavior in comparison to messages framed with a general plea or information

pertaining to state law (Cialdini et al., 2006; Goldstein et al., 2008). Chapter IV examines the structure of normative social influence by asking how and why aspects of social comparison affect the relationship between normative social beliefs and behavior.

2. EXTENDING THE RETURN POTENTIAL MODEL FOR SOCIAL NORM RESEARCH

Introduction

Normative social beliefs are ubiquitous element of social interaction and behavior, playing important roles in individual decision-making, behavior regulation, and environmental management practices (Bicchieri, 2006; Heberlein, 2012; Hetcher & Opp, 2001). Normative social beliefs refer to those held by individuals concerning the behavior(s) others do or approve of doing in a particular situation (Farrow, Grolleau, & Ibanez, 2017; Schultz, Tabanico, & Rendón, 2008). These beliefs often coincide with the actual or perceived possibility of social sanction (Horne, 2009). The aggregation of individual normative social beliefs within a group provide evidence of a perceived social norm, defined as an informal, socially constructed rule that guides individual behavior towards a group's or setting's behavior standard (Nolan, 2016). Two widely used approaches in social-environmental fields to understand normative social beliefs and the influence they have on behavior are (1) the structural characteristics approach (SCA; also termed the normative approach), based on the return potential model (RPM) (Jackson, 1965; Nolan, 2015; Vaske, 2008), and (2) the focus theory of normative conduct (FT) (Cialdini, Reno, & Kallgren, 1990; Cialdini, 2012).

The SCA quantifies the strength and structure of normative social beliefs by measuring perceptions, via an aggregation of individual ratings, of a behavior's approval or acceptability within a group or setting (Vaske & Whittaker, 2004; Manning, 2013).

This provides researchers and managers with information about what behavior(s) individuals within a group perceive as typical or expected, and, importantly, a means to evaluate the existence and difference between normative social beliefs across groups or settings (Heywood, 2000). However, according to FT, approval represents only one dimension of normative social beliefs. Focus theory posits that what individuals approve of (or believe others approve of) and what they do (or believe others do) are two distinct dimensions, having separate sources of information and motivation to influence behavior (Cialdini et al., 1990; Deutsch & Gerard, 1955). Injunctive beliefs (what is approved) provide information about what behavior that is socially (dis)approved, motivating individual behavior via an assurance of social reward or avoidance of social punishment. Descriptive beliefs provide information about what behavior is (un)common and likely effective, motivating individual behavior via social proof. These two dimensions of normative social beliefs can exist and influence behavior independently but often exist concurrently and interactively within the same setting (Cialdini, 2008; Schultz, Nolan, Cialdini, Goldstein, Griskevicius, 2007).

An assumption of the SCA is that ratings of (dis)approval represent a social norm or normative standard. Yet descriptive beliefs, perceptions of how common a behavior is and/or levels of engagement in that behavior, are also integral to understanding a perceived social norm and potential difference across groups or settings. Not measuring descriptive normative beliefs implies that (dis)approved behavior is common behavior, or vice versa, which is tenuous (Brauer & Chaurand, 2009). The inclusion of a descriptive belief measure within the SCA framework can remove this assumption and

the potential to subsume or conflate "ought" with "is" (Cialdini et al., 1990), and represents a logical extension of the SCA research tradition given the theoretical refinements offered by FT. Therefore, the purpose of this study is to incorporate a measure of descriptive beliefs into the SCA and RPM, providing a complementary and fuller conceptualization and operationalization of normative social beliefs and perceived social norms within social-environmental settings.

Literature review

The return potential model

The SCA originates from the RPM, a method originally designed to understand normativeness and standards of behavior in the context of social roles (Jackson, 1965). Researchers employ the RPM to measure and characterize social consensus regarding perceived levels of approval or acceptability across a behavior range for a particular context. An important assumption of the RPM that distinguishes it from other conceptualizations of social norms is it defines them as a process rather than a static, single behavior (Nolan, 2015). The RPM assumes an individual's normative social beliefs form around a spectrum of related behaviors (behavior dimension), as opposed to a single behavior. Individuals may believe a specific behavior is ideal but often accept or approve of other behaviors proximate to that ideal. That is, instead of perceiving a single, uncompromising behavior as correct and any derivation from it as incorrect, individuals often hold a range of normative social beliefs for a behavior or practice. For instance, individuals approve of others recycling but the extent to which others recycle,

how often or how much, affects approval or acceptability (Nolan, 2015). By measuring individual's normative beliefs across or range of related behaviors, researchers gain an understanding of the form and specificity of a perceived social norm (e.g., is two pounds of recycling per week enough or too little to gain others approval, five pounds, ten pounds?); RPM enables examination of this range and its characteristics.

The RPM has three primary structural components that quantify normative beliefs; a behavior dimension (x-axis), a return potential dimension (y-axis), and the return potential curve plotted in two-dimensional space as defined the first two dimensions (Figure 1). To quantify the behavior dimension, the RPM assumes the behaviors of interest lie along a single behavior dimension, which are plotted along the x-axis and arranged from least to greatest degree of the behavioral engagement. This is required because the RPM assumes any relation between the level of (dis)approval and the level of behavior is due to the norm, requiring the behavior dimension to be independent of approval measures (Henry et al., 2004). To quantify the return potential dimension, researchers obtain ratings of (dis)approval for each behavior within the behavior dimension of interest, which are plotted along the y-axis. Plotting ratings of approval (y-axis) as a function of behavior (x-axis) creates the third component, the return potential curve. The return potential curve provides a graphical illustration of norm structure and strength, with consistent ratings above or below the origin providing evidence of a perceived social norm pre- or proscribing behavior.

These three structural components provide further information, i.e., six norm metrics (Table 1). Norm metrics enable researcher and manager to evaluate the

existence, strength, and characteristics of the perceived social norm or behavior standard based on low or high ratings. That is, the perceived social norm identified by a RPM, derived from the frequency of (dis)approval rating, is a socially constructed phenomenon and individual models are not appropriately evaluated by an a priori frequency distribution. For instance, consistent ratings above or below 0 (i.e., ±1 or ±2; Figure 1) provide initial evaluation criteria that a perceived social norm (pre)proscribing behavior exists, but this distribution may differ from context to context. Thus, the norm metrics provide measures that are used to evaluate individual RPMs and can be compared across groups or settings.

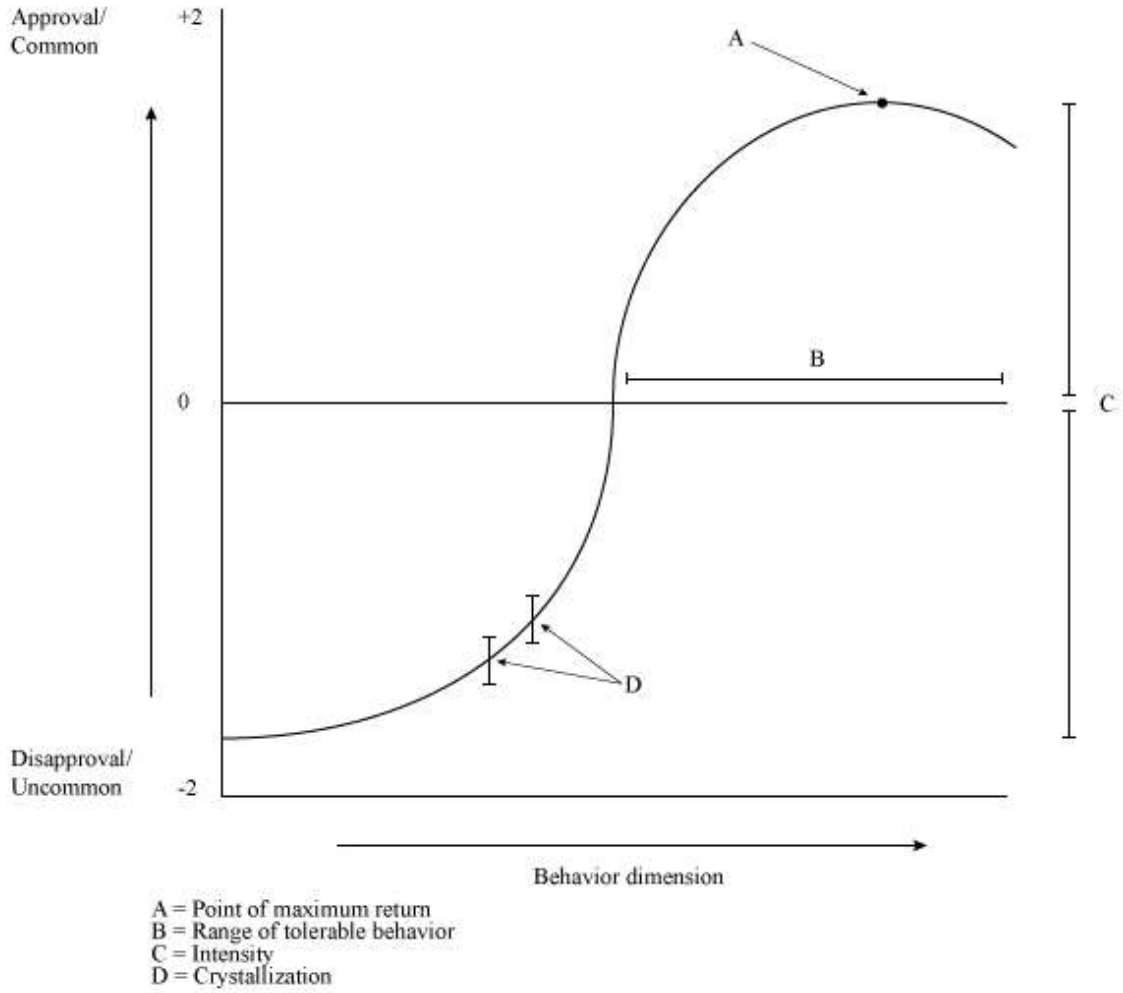

Figure 1. Graphical representation of a return potential model, or impact acceptability curve, as it is referred to within the structural characteristics approach.

The structural characteristics approach

The RPM has been widely applied to examine the existence and level of social approval a behavior(s) garners in various context, ranging from customer service standards (Jackson, 1975), work absences (Sasaki, 1979), leadership behavior (Torres,

1999), voting behavior (Glynn, Huge, & Lunney, 2009), opinion expression (Glynn & Huge, 2007), and aggressive behavior (Henry, Cartland, Ruchcross, & Monahan, 2004). In social-environmental and natural resource contexts, the basic conceptual and methodological tenets of RPM are appropriated by the SCA to evaluate standards of normative behavior and conditions.

The SCA uses the RPM to obtain ratings of approval along a behavior dimension and graphically represents those ratings (Shelby et al., 1996; Vaske, Shelby, Graefe, & Heberlein, 1986; Vaske & Whittaker, 2004). Over the past four decades, the SCA has been employed in various natural resource and outdoor recreation contexts to understand normative standards of behavior and conditions related to user impacts, trail encounters, and crowding (Needham, Vaske, Whittaker, & Donnelley, 2014; Shelby, Vaske, & Harris, 1988). The application to conditions, apart from individual behavior, distinguishes the SCA from other RPM studies. This distinction is due, in part, to the applied management context in which researchers were seeking to provide managers with information necessary to develop management policy (Vaske & Whittaker, 2004).

In management context, the SCA has been used to understand standards of conditions related to trails and campsites (Hammitt & Rutlin, 1995; Kim & Shelby, 2005; Shelby et al., 1988). Vaske et al. (1986) conceptualized "number of individuals encountered" as the behavior dimension and measured users' (dis)approval to understand normative beliefs about the acceptable number of encounters that users should experience in a backcountry recreation setting. As an evaluation of conditions, rather than individual behaviors, this SCA application of the RPM can provide managers

with bounded management objectives. Others researchers have used images of a range of conditions as the behavior dimension to evaluate normative standards related to encounters and crowding in various recreational or natural resource settings (e.g., Manning, Lime, Freimund, & Pitt, 1996). Outside the recreational domain, structural characteristic studies have been applied to evaluate normative standards for behavior and management conditions in various natural resource context, such as wildfire management (e.g., Absher, Vaske, Bright, & Donnelley, 2006; Kneeshaw, Vaske, Bright, & Absher, 2004) biodiversity conservation (Bettigole, Donovan, Manning, & Austin, 2014; Bettigole, Donovan, Manning, Austin, & Long, 2014), and adaptive management (Smyth, Watzin, & Manning, 2007).

The SCA, being primarily a descriptive methodology, is useful as a standardized method for resource managers to understand the normative beliefs concerning expected behaviors and conditions held by their constituency (Manning & Lime, 2000). From a management perspective, the SCA can also: (a) focus managers on goals or actions deemed desirable or appropriate by users, (b) define the characteristics of optimal resource conditions, (c) further define the standards for those conditions, (d) differentiate minimal acceptable conditions from optimal, (e) identify issues or resources important to constituents, and (f) provide manager with an understanding of consensus among constituents or segments of their constituency (Shelby et al. 1996). Heywood (1996) suggests SCA studies should recognize the distinction between a social convention and a social norm; the former being more akin to a behavioral preference and not necessarily being enforced via sanctioning. That is, in some context, it is necessary to understand if

individuals are indicating an obligatory pro/prescription or simply a preference. This is consistent with other criticisms of social norm research not accounting for sanctions, positive or negative (Horne, 2009), which can be partly ameliorated by measuring both descriptive and injunctive beliefs (Schultz et al., 2007).

Table 1. Return potential model metrics and descriptions.

Metric	Description
Point of maximum return (PMR)	Behavior associated with the greatest approval, i.e., the apex of the return potential curve (A, Fig. 1)
Range of tolerable behavior (RTB)	Related to viewing a norm as a process; measures all levels of the behavior to the right of where return potential curve crosses the point of indifference (B, Fig. 1).
Intensity	Representative of norm strength, e.g., an increase in overall expressed approval or disapproval across behavior dimension indicates greater intensity. This measure remains independent of positive or negative valence, i.e., strong positive and negative ratings have equal intensity (C, Fig. 1).
Potential return difference (PRD)	Difference between positive and negative elements of intensity; a positive PRD indicates the norm is enforced primarily via approval (reward); negative score indicates enforcement primarily via disapproval (punishment).
Crystallization	Degree of consensus; crystallization occurs when group tends to agree strongly about approval or disapproval of behaviors, i.e., low variance in associated ratings (D, Fig. 1).
Normative power	Normative power combines intensity and crystallization, reflecting the extent to which behavior is normatively regulated: (a) high intensity/ high crystallization indicates strong agreement about approved behavior (intensity); (b) low intensity/ low crystallization indicates lack of normative regulation; (c) high intensity/ low crystallization indicates potential or emerging normativeness; (d) low intensity/ high crystallization indicates agreement about appropriate behavior but lack of concern.

The focus theory of normative conduct

Since the early 1990s, a large amount of research has expanded our understanding of normative beliefs and social norms. Perhaps the most important theoretical advance and definitional refinement has been the focus theory of normative conduct (Cialdini et al., 1990). Focus theory makes two important contributions, (1) it defines and delimits descriptive and injunctive normative social beliefs as two distinct dimensions, each with a unique motivational and information source (Deutsch & Gerard, 1955) and (2) posits that normative social beliefs motivate behavior most effectively when they are salient. This paper focuses on the former and its relation to the measurement of descriptive normative beliefs within the SCA and RPM.

Descriptive normative social beliefs refer to behaviors perceived to be typical or common; representing a belief about what behavior is done. The normative information provided by a descriptive norm originates in observing, knowing, or surmising what most people do in a particular situation, motivating behavior by providing evidence as to what action(s) is likely to be effective or adaptive (i.e., social proof) (Cialdini et al., 1990; Cialdini, 2007). Injunctive normative social beliefs refer to behaviors perceived to be approved, appropriate, or expected; representing beliefs about what behavior ought or ought not be done (i.e., proscribed or prescribed) for a particular social setting (Winter, Cialdini, Bator, Rhoads, & Sagarin, 1998). The normative information provided by an injunctive norm originates in understanding the informal social rules or guidelines for a particular situation, motivating behavior through the potential of receiving social rewards or punishments (Horne, 2009). Since focus theory's seminal studies, a large

body of literature has empirically tested its tenets, specifically those regarding the influence of descriptive and injunctive norms, often in the context of pro-environmental behaviors (Cialdini, 2012).

Research has demonstrated the influence of an injunctive norm, both prescriptive and proscriptive. For example, in a context where an undesirable (e.g., antisocial) behavior is common, an injunctive norm is more effective at reducing the undesirable behavior or influencing a more desirable, prosocial behavior (Cialdini, Demaine, Sagarin, Barrett, Rhoads, & Winter, 2006). Injunctive norms are also thought to influence behavior in greater variety of social settings, particularly when an individual is uncertain about their descriptive normative beliefs (Reno, Cialdini, & Kallgren, 1993).

Research has also demonstrated the influence of descriptive norms (Bicchieri & Xiao, 2009; Cialdini, 2007). For example, self-reported descriptive normative beliefs were more predictive of individuals' intention than other relevant beliefs in the context of household energy conservation (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Similarly, but within a public setting, individuals' energy conservation behavior was significantly influenced by a descriptive norm compared to a control (Dwyer, Maki, & Rothman, 2015). Descriptive norms embedded in messages and signs have also been shown to increase pro-environmental behavior in comparison to control and non-normative messages (Goldstein, Cialdini, & Griskevicius, 2008). In situations where an individual's role in affecting change is salient or the situation's goals are self-focused evidence suggest descriptive norms most effective compared to injunctive (White & Simpson, 2013). Together, these findings suggest descriptive norms influence both

individual private and public behavior. Descriptive norms have also been incorporated into other theoretical frameworks, i.e., theory of planned behavior, providing additional predictive power (Fishbein & Ajzen, 2010; Rivis & Sheeran, 2003).

Research has shown the distinct nature of these social norm dimensions, but also their interactions and, at times, their interdependence (Jacobsen, Mortensen, & Cialdini, 2011; Schultz et al., 2007; Smith & Louis, 2008). For example, injunctive normative beliefs were shown to moderate the influence of descriptive norms on self-reported energy conservation behaviors (Göckeritz, Schultz, Rendón, Cialdini, Goldstein, & Griskevicius, 2010). In addition to their descriptive norm findings, White and Simpson (2013) found the pairing of both descriptive and injunctive appeals was particularly effective in situations where individuals were focused on the benefits to society, i.e., collectively-focused, in comparison to self-focused treatments. In settings where descriptive and injunctive beliefs operate simultaneously, there is potential for (mis)alignment or conflicting perceptions of the social norm (Smith et al., 2012). Studies have examined the efficacy of aligning norms when they exist concurrently within a setting. For example, Thøgersen (2008) reports a positive interaction effect, suggesting an injunctive norm is most relevant and influential when aligned with the descriptive norm. Conflict between injunctive and descriptive norms can lead to weaker behavioral influence, highlighting the need to consider the interplay between injunctive and descriptive norms (McDonald, Fielding, & Louis, 2013; Smith, Louise, Terry, Greenaway, Clarke, & Cheng, 2012).

Present study

Conventional application of SCA and RPM are limited in their ability to account for descriptive beliefs. Empirical research within the SCA and RPM frameworks has yet to address this limitation, although refinements to social norm theory and conceptualizations of normative social beliefs would suggest this is a needed extension. Given this gap between theoretical advancement and empirical application, the purpose of this study is to extend the SCA framework and RPM methodology by measuring commonness (descriptive belief) alongside approval (injunctive belief). We ask, how do ratings of approval and commonness across a behavior dimension potentially differ and what implications do those potential differences have for SCA and RPM research and natural resource management? To answer these questions, we explore ratings of approval, commonness, and associated norm metrics within an applied natural resource management context and place these results within past and contemporary SCA and FT literature.

Methods

Study context

This study was part of a statewide cross-sectional data collection effort to understand Texas boaters' perceptions of AIS management, boating practices, and AIS mitigation behaviors in public freshwaters. Throughout Texas, various AIS populations have established or have been observed in public freshwaters. These waters provide recreational opportunities to boaters, anglers, etc., but also provide various services, i.e.,

hydroelectric, flood control, and drinking water. A primary AIS vector is often resource users who move between various waterbodies, e.g., boaters (Anderson, Rocliffe, Haddaway, & Dunn, 2015; Johnson, Ricciardi, & Carlton, 2001; Kelly, Wantola, Weisz, & Yan, 2013; Vander Zaden & Olden 2008). This recognition, coupled with the presence of prolific AIS, e.g., zebra mussels (*Dreissena polymorpha*), has spurred management initiatives to examine the prevalence and expectation of boater AIS mitigation behaviors that reduce AIS impact and spread (McLeod, Hine, Please, & Driver, 2015).

Currently, Texas public freshwater management agencies, who also license boaters, employs a Clean, Drain, Dry™ (CDD) public awareness campaign to influence boater AIS mitigation behavior by providing them with information about the actions they can enact to reduce AIS impact and spread. These include cleaning, washing, disinfecting, draining, and drying the boat and equipment. Given the social and public context in which recreational boating and these behaviors presumably occur, normative social beliefs likely play a role in boaters' perception of the social norm and subsequent decision engage in the necessary AIS mitigation behaviors. However, the extent to which AIS mitigation behaviors are perceived as approved or common is unknown. This provides an ideal context to investigate and employ measures of both approval and commonness within a SCA and RPM framework.

Participants

Participants consisted of 9,500 licensed boaters randomly selected from the Texas Parks and Wildlife Department's (TPWD) boater registration database, who provided email addresses. Participants were solicited via email and provided a link to a questionnaire, which was administered through the web-based Qualtrics research software (Qualtrics, 2016). Following tailored design protocol, participants were contacted via email up to five times, approximately one week apart, until they completed the questionnaire or opted-out (Dillman, Smyth, & Christian, 2014). After accounting for bounced emails and voluntary opt-outs, 8,609 participants received an invitation, with 2,324 questionnaires completed or partially completed (27% effective response rate). Of these, 1,518 participants completed the requisite RPM measures, and account for the data used in this study.

Participants' ages ranged from 19-85, with a mean age of 55.5 (91.4% male, 8.6% female; 94% white; 5.6% Hispanic). Twenty-one percent of participants reported high school as their highest level of education, with 23.8% reporting a vocational or two-year degree, 35.7% a four-year college degree, and 18.5% reporting a graduate degree. (<1% reported less than high school). A gross annual income of over $120,000 was reported by 50.8% of participants, with 36.3% under $120,000 and 12.9% under $60,000.

Materials

In addition to socio-demographic, we collected data on participants' past CDD behavior. Participants were asked to recall their boating activity over the past 12 months and indicate on how often they, "cleaned my boat, gear, and trailer and removed any mud, plants, and animals before transporting my boat to another public waterbody"; "washed my boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody"; "drained all water from my livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody; "dried my boat and trailer for at least 7-10 days before launching into other public waters" (1 = never, 2 = sometimes, 3 = about half the time, 4 = most of the time, 5 = always). We also collected data on participants' AIS awareness, knowledge, and mitigation behaviors. Participants were asked to indicate, "prior to taking this survey, how aware were you of Texas state laws requiring boaters to clean gear and drain boat after using public waterbodies?" and "how knowledgeable were you about the presences of aquatic invasive species in Texas freshwaters?" (1 = not at all, 2 = somewhat, 3 = very).

Six behavior vignettes, derived from Henry et al. (2004) and Nolan (2015) were adapted to the context of this study to represent the range of AIS mitigation actions available to boaters. To meet the assumption of the RPM that rated behaviors should lie along a single behavior dimension, vignettes ranged from a description of boater who does not engage in any Clean, Drain, Dry behaviors to a boater who engages in all three behaviors every time they boat (Figure 2). Participants were asked to rate their level of

approval on a 5-point Likert scale from 1 = definitely disapprove (recoded -2) to 5 = definitely approve (recoded +2). To incorporate the descriptive dimension, an additional scale was developed asking participants to rate their perception of how common these behaviors are on 5-point Likert scale, ranging from 1 = very uncommon (recoded -2) to 5 = very common (recoded +2).

Two return potential curves were created based on injunctive and descriptive beliefs pertaining to the six AIS mitigation behaviors, i.e., measures of approval and commonness, respectively. This was accomplished by plotting the six vignettes capturing the AIS mitigation behavior dimension along the x-axis and recoded levels of approval and commonness were plotted along the y-axis. Norm metrics were derived from the resulting return potential curves and scored separately (Table 2). These metrics were calculated as follows. The point of maximum return is observed as the behavior vignette receiving the highest mean rating. Range of tolerable behavior is calculated by subtracting the behavior vignette receiving the lowest positive ranking (any rating greater than 0) from the highest rated positive vignette. Intensity is calculated as the mean of the absolute values of each behavior vignette's average rating. Crystallization is calculated as the average variance in ratings across all behaviors. Normative power, a combination of intensity and crystallization scores, is calculated, first, by taking the absolute value of intensity scores for each behavior and converting this into a proportion by dividing it by its maximum value. Next, the crystallization score for each behavior is converted into a proportion by dividing by its maximum value. This value is then subtracted from 1. The two resulting terms from intensity and crystallization are then

multiplied, giving us a normative power score from 0-1 for each behavior (Nolan, 2015). To calculate overall normative power for each model, we averaged these scores across the six behaviors. Potential return difference is calculated by summing all positive intensity scores and subtracting all negative intensity scores, resulting in a positive or negative value, or zero (Henry et al., 2004).

Results

Awareness of AIS and past mitigation behaviors

Participants' self-reported CDD behaviors over the past 12 months were relatively consistent and high across all four measures: clean (M = 4.16, SD = 1.44); wash (M = 3.58, SD = 1.67); drain (M = 4.37, SD = 1.35); dry (M = 4.07, SD = 1.48). Participants self-reported awareness (2.63, SD = 0.59) and knowledge (M = 2.24, SD = 0.55) prior to completing the questionnaire were also relatively high and consistent.

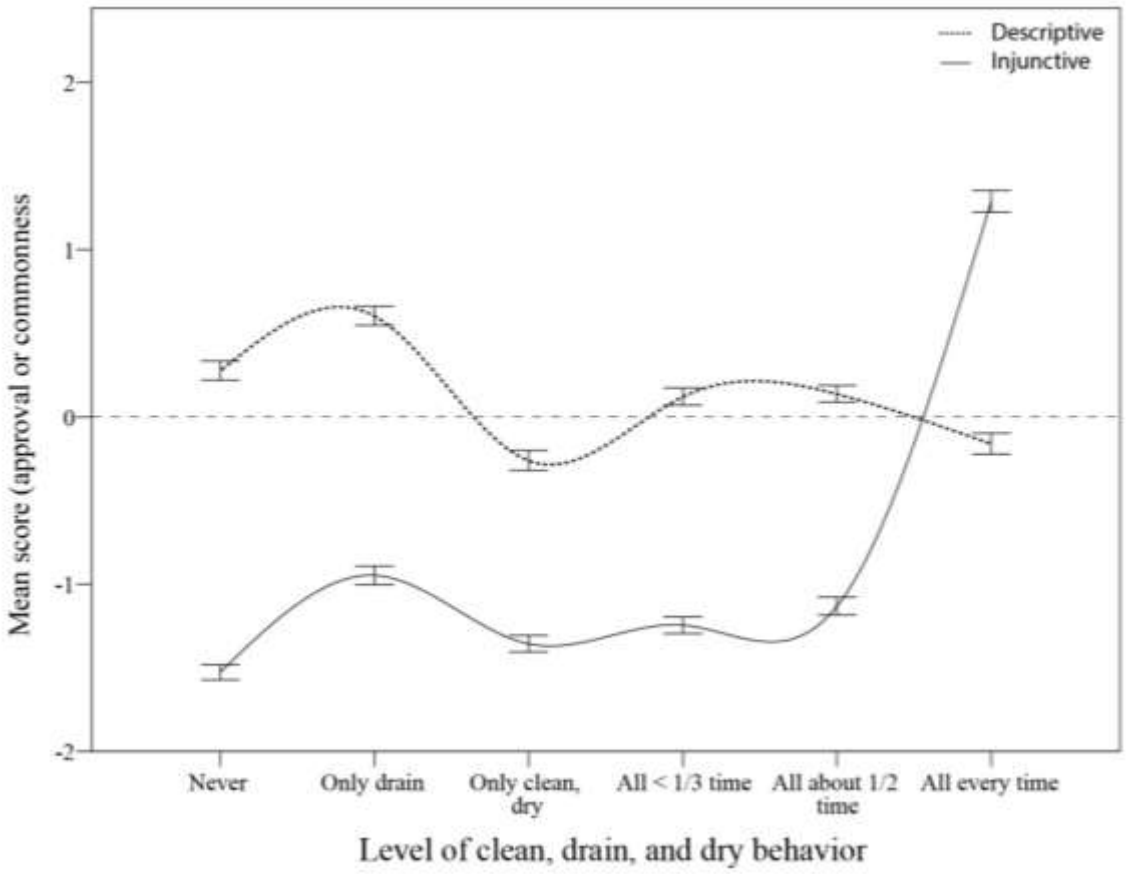

Figure 2. Mean approval and commonness across levels of clean, drain, dry behavior (±SE).

Descriptive and injunctive return potential of AIS mitigation behaviors

AIS mitigation behaviors varied significantly across descriptive and injunctive models (Table 2, Figure 2, 3). Figure 2 illustrates the distinct nature of each return potential curve measuring participants' ratings of approval and commonness, and, therefore, the structure of injunctive and descriptive normative beliefs and the perceived social norm. To examine variation in ratings of approval and commonness for each AIS mitigation behavior, a Chi-square test was used. Results revealed participants' ratings of

behaviors were significantly different across approval and commonness: never: (χ^2 = 110.90, df = 16, $P < 0.001$, Cramer's $V = 0.14$); only drain: (χ^2 = 96.33, df = 16, $P <$ 0.001, Cramer's $V = 0.13$); only clean and dry: (χ^2 = 113.86, df = 16, $P < 0.001$, Cramer's $V = 0.15$); CDD ⅓ time: (χ^2 = 116.52, df = 16, $P < 0.001$, Cramer's $V = 0.14$); CDD ½ time: (χ^2 = 108.70, df = 16, $P < 0.001$, Cramer's $V = 0.13$); CDD every time: (χ^2 = 119.53, df = 16, $P < 0.001$, Cramer's $V = 0.14$). Figure 3 further highlights differences in the frequency distribution of Likert responses for each behavior.

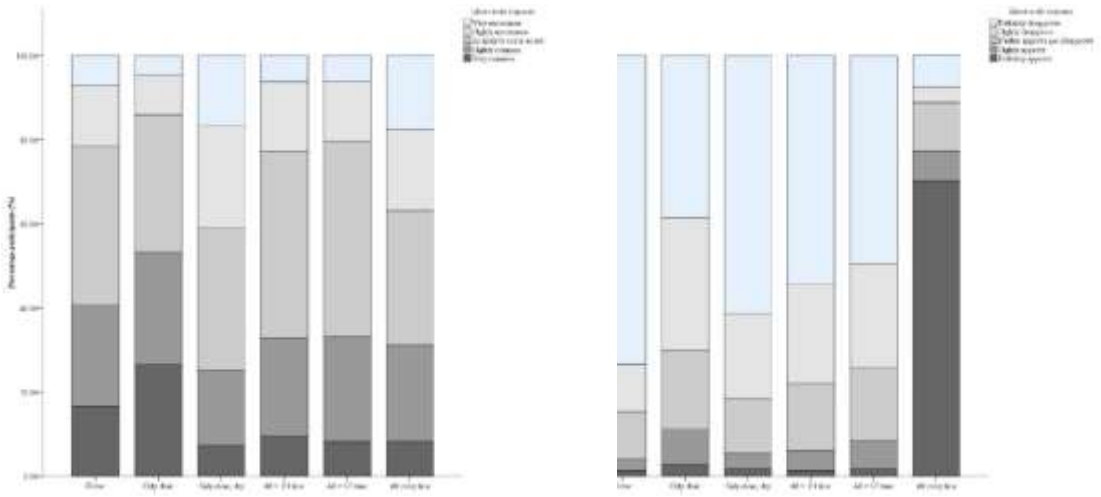

Figure 3. Histogram (stacked) of responses within each clean, drain, and dry behavior across measures of approval and commonness.

Norm metrics of AIS mitigation behaviors

Overall, mean ratings of approval increased as the level of CDD behavior increased (Table 2, Figure 2). For the injunctive model, the vignette describing a boater who "does all clean, drain, dry every time s/he goes boating", garnered the highest

approval among participants, representing both the PMR and the RTB (i.e., it was only AIS mitigation behavior rated above 0) (Table 3). In contrast, mean ratings of commonness remained near 0 (i.e., "as likely to occur as not) in the descriptive model. The PMR for the descriptive model was the vignette of a boater who "drains the water but does not clean or dry" and an ambiguous RTB was observed, with ratings of (un)commonness crossing the origin twice (Figure 2).

Variation across models for the remaining norm metrics was examined using an independent samples *t*-test. Results indicate intensity ($t = 7.25$, df = 10, $P < 0.001$), potential return difference ($t = 5.14$, df = 10, $P < 0.001$), and normative power ($t = 3.13$, df = 10, $P < 0.05$) differed significantly across the two dimensions of normative social beliefs. These results indicate significant difference across injunctive and descriptive models (Table 3).Crystallization did not vary significantly across models ($t = 0.95$, df = 10, $P = 0.37$).

Table 2. Ratings of normative social beliefs regarding CDD behavior approval and commonness (not recoded).

	Injunctive (approval)	Descriptive (common)
	Mean (SD)	Mean (SD)
Never	1.45 (0.86)	3.31 (1.11)
Only drain	2.07 (1.08)	3.66 (1.02)
Only clean and dry	1.62 (0.94)	2.74 (1.15)
CDD ⅓ time	1.74 (0.97)	3.15 (1.16)
CDD ½ time	1.87 (1.03)	3.15 (0.96)
CDD every time	4.33 (1.21)	2.79 (1.20)

Note: Mean score value on scale of 1 (definitely disapprove/uncommon) to 5 (definitely approve/common). All ratings significantly different across groups, $p < 0.001$ level.

Table 3. Norm metrics for injunctive and descriptive return potential models.

	Injunctive (M, SD)	Descriptive (M, SD)
Point of maximum return	All every time	Only drain
Range of tolerable (typical) behavior	All every time	Never–only drain
Intensity***	1.46 (0.17)	.85 (0.12)
Crystallization	1.08 (0.27)	1.20 (0.18)
Normative (empirical) power*	.29 (0.12)	.13 (0.02)
Potential return difference***	-.40 (0.11)	-.02 (0.14)
*Never****	*-.52*	*.07*
*Only clean****	*-.30*	*.18*
*Only clean and drain****	*-.42*	*-.12*
*All ⅓ time****	*-.45*	*.01*
*All ½ time****	*-.48*	*-.05*
All every time	*-.23*	*-.22*

Note. *p<.05, ***p<.001

Discussion

The objective of this study was to incorporate the theoretical and conceptual refinement of FT into SCA and RPM by measuring injunctive (approval) and descriptive (commonness) normative beliefs across the same behavior dimension. In general, results reveal a single-tolerance injunctive normative standard for Texas boaters—to perform all AIS mitigation behaviors every time they boat—as this behavior representing both the point of maximum return and range of tolerable behavior. This is in contrast to the observed descriptive normative standard across the same behavior dimension, which indicates boaters perceive various levels of AIS mitigation behaviors as likely to occur as not, as indicated by an indeterminate RTB and PMR. Further analysis of norm metrics also indicate significant difference between intensity, normative power, and potential return difference across injunctive and descriptive models. These results provide initial empirical evidence that injunctive and descriptive standards manifest with distinct

structures and characteristics within the same behavior dimension and context, demonstrating the usefulness of applying an extended SCA and RPM.

Theoretical implications

Prior to interpreting the results of this study, clarification of the descriptive model and its norm metrics is required. The definition and interpretation of a descriptive PMR remains straightforward, it indicates the behavior individuals think is most common in a given situation. For a descriptive model, the RTB refers to the range of *typical* behaviors engaged in by group members and those likely to provide social proof, defined by mean behavior ratings above 0. Descriptive intensity provides a measure of empirical expectations, i.e., what behavior others are likely to do (Bicchieri & Xiao, 2009) and can be interpreted as a likelihood that others within a population believe a behavior is (un)common. Intensity can be interpreted as an indicator of the salience of social proof (or lack thereof). That is, a high intensity score suggest a higher likelihood of a behavior occurring (or not occurring), providing social proof that a behavior is (in)correct the situation (Cialdini, 2007). For a descriptive RPM, crystallization represents empirical consensus and/or the perceived consistency of engagement in a behavior. High descriptive crystallization (low variance) indicates there is agreement that low levels of a behavior are uncommon, high levels common, and that those behaviors are perceived and actually being enacted by individuals consistently. Conversely, low crystallization would suggest relatively less consensus regarding behavior consistency among group members. Empirical power, the term we suggest as

that descriptive counterpart to normative power, refers to the extent that behavior is (has been) empirically normalized as (un)common. As a combination of intensity and crystallization scores, empirical power provides an indication of whether a descriptive norm is established, emergent, or yet to operate in a particular context. Potential return difference provides information about sanctions, and the tendency of a group to emphasize reward or punishment for behavior regulation. However, while PRD can be calculated, there is no descriptive equivalent in terms of interpretation, as sanctions are an element of the injunctive dimension (Horne, 2009). These definitions and distinctions of injunctive and descriptive norm metrics facilitate our remaining discussion.

Acquiring and quantifying participants' ratings of (dis)approval and (un)commonness for AIS mitigation behaviors acknowledges the existence of both normative dimensions and measure and observe variation. This study, as an initial attempt to measure both normative dimensions, observed significant variation in perceived descriptive and injunctive normative standards, which is consistent with past empirical work (Blanton, Köblitz, & McCaul, 2008; Park & Smith, 2007). Whereas the injunctive model indicates a single-tolerance normative standard, the descriptive model is less definitive as to the existence of a single, multiple, or no-tolerance normative standard (Whittaker & Shelby, 1988). From a theoretical perspective, these results serve as an extension of the SCA and RPM, highlighting the importance of obtaining both injunctive and descriptive standards when examining behavior standards, rather than conditions. Without the inclusion of descriptive standards, subsuming ought with is, a potential to conflate injunctive and descriptive beliefs and perceived norms remains. As

in this study, wherein injunctive and descriptive models varied significantly, others have observe distinct injunctive and descriptive norms operating concurrently in the same context and their effect on behavior regulation (Thøgersen, 2008; McDonald et al., 2013). Significant variation, or misalignment, of injunctive and descriptive normative beliefs can have substantial implications for behavior regulation (Smith et al., 2012). Others demonstrate the behavioral outcomes related to (mis)aligned or conflicting norms (McDonald, Fielding, & Louis, 2014; Smith et al., 2012) and the potential to complement one another (Schultz et al., 2007).

The comparison of norm metrics lends additional support. Only one CDD mitigation behavior accounted for the injunctive RTB. In contrast, the descriptive RTB (and PMR) was less definitive, as the first two actions in the CCD behavior dimension were rated only slightly above 0 (as likely to occur as not), then the third below, the next two slightly above, and, finally, the last action below zero. This ambiguity in the descriptive model suggests empirical expectations are limited, i.e., they either do not yet exist or simply do not play a substantial behavior regulation role. The latter is more plausible as participants self-reported relatively high levels of awareness and past behavior, suggesting these behaviors are common but not particularly salient (i.e., low intensity and empirical power). Measures of intensity, crystallization, and empirical power provide additional corroboration; descriptive intensity was relatively low, implying a weak norm, yet crystallization was relatively high, which suggests consensus among participants as to how common behaviors are. Combined as an empirical power score (Table 3), low intensity and high crystallization suggest individuals follow the

norm, but that it is of little concern (Jackson, 1975; Nolan, 2015). This is in contrast to injunctive intensity, crystallization, and normative power; wherein intensity is high, crystallization low, and normative power suggests the normative standard is emerging and likely not wide-spread and enforced (Heywood, 1996).

Managerial implications

The results of this study suggest Texas boaters approve of other boaters doing all AIS mitigation behaviors every time they boat and do not approve of any behaviors that do not reach this standard. However, participants' self-reported past behavior suggests this is not what most boaters do and, likewise, the descriptive model suggests boaters hold ambiguous normative beliefs regarding the commonness of AIS mitigation behaviors (or may be reporting socially desirable responses). In this management context, this is not an ideal behavior standard; AIS is an exigent management concern that necessitates a behavior standard of all AIS mitigation behaviors ought to be done after every boating excursion to mitigate the negative impacts of AIS. These results shed light on the importance of quantifying both normative standards to offer a more complete picture of perceived social norm characteristics and strength. As management agencies are often interested in understanding and quantifying the behaviors of resource users, it is also pertinent to quantifying their beliefs about what others are doing, as this can affect their choice to engage in those very behaviors. Management agencies that already survey their constituents and collect data on behavior and preferences may consider incorporating an extended RPM into their questionnaires, as data on both

behavior (reality) and normative social beliefs (perception) is informative and useful (Heywood, 2000; Manning, 2013). The inclusion of an extended RPM, apart from collecting necessary information, also enables comparison of normative beliefs and behavior standards across locations and time. For instance, descriptive information allows managers to not only understand the behaviors resource users perceive as common but provides insight into what behaviors are salient and, perhaps, need to be more or less salient, or overt. In the context of AIS, a descriptive RPM can identify if perceptions of other behavior changes with the implementation of new management practices (e.g., boat wash stations) or regulatory policies (e.g., state laws prohibiting transport of species between waterbodies). The same is can be said for an injunctive RPM and measures of approval before and after implementation of a management policy.

As previously noted, in context where individual behavior is of concern, rather than conditions, having information regarding only injunctive beliefs is useful but limiting. Having information on both provides managers with alternative insights and management options. For example, corroborating descriptive normative standards and their influence on behavior is more straightforward than that of approval or acceptability (e.g., Nolan et al., 2008). Given the limitations of self-reported behaviors and beliefs (e.g., issues of social desirability bias), a descriptive SCA and RPM provides managers with the ability to validate survey data with observation of behavior, whereas approval (sanctions) is less observable in a management setting. Together, these data may inform managers as to what normative beliefs need facilitated or impeded via public awareness

campaigns and management practice (e.g., Cialdini et al., 2006). In the context of this study's results, data on self-reported behavior and the descriptive RPM suggest managers need to facilitate the belief that doing all clean, drain, and dry behaviors associated with AIS mitigation are common and typical behaviors among Texas boaters.

Directions for future research

Synthesizing theoretical insights from two domain of social norm research provided useful conceptualization and operationalization that contributes to and advance theory and practical application. Extending the structural characteristics approach and return potential model to measure perceptions of common behavior based on the theoretical and definitional refinements of the focus theory of normative conduct adds to the growing body of literature on social norm research in applied settings. Future research may replicate or apply this extended RPM and SCA to other context to understand its efficacy and suitability. As noted above, the descriptive model, presumably, is most appropriate for studies evaluating individual behavior rather than conditions (Shelby et al., 1996; Vaske & Whittaker, 2004). Management agencies may find a combined RPM more informative, providing them with an alternative perspective on normative beliefs and standards that can translate into practical solutions. In the context of AIS, this study also continues a trend of incorporating the human dimensions and a focus on behavior that can inform management action and applied research.

3. THE EFFICACY OF MESSAGE FRAMING ON AQUATIC INVASIVE SPECIES MITIGATION BEHAVIOR INTENTION AMONG RECREATIONAL BOATERS

Introduction

The introduction and establishment of aquatic invasive species (AIS) affects biological health, economic interests, industrial infrastructure, and human wellbeing (McNeely, 2001; Pimentel, Zuniga, & Morrison, 2005; Ricciardi & MacIsaac, 2011). This has led to extensive research and policy on the effects AIS have on native species, ecological stability, and societal interests (Genovesi & Shine, 2004; Lockwood, Hoopes, & Marchetti, 2013; NISC 2008). Increasingly, focus is shifting to prevention rather than response, as preventing AIS is often less expensive than response and control practices (Lovell, Stone, Fernandez, & 2006; Vander Zanden & Olden, 2008). Preventive management practices often attempt to change users' behavior (e.g., boaters and anglers) to reduce user-related introduction and spread (Anderson, Rocliffe, Haddaway, & Dunn, 2015; Clarke Murray, Pakhomov, & Therriault, 2011; Johnson, Ricciardi, & Carlton, 2001; Kelly, Wantola, Weisz, & Yan, 2013; Pradhananga, Davenport, Seekamp, & Bundy, 2015; Rothlisberger, Chadderton, McNulty, & Lodge, 2010).

The focus on prevention and user behavior necessitates human-centered research and practice (García-Llorente, Martín-López, González, Alcorlo, & Montes, 2008; Heck, Stedman, & Gaden, 2015; Hine, Please, McLeod, & Driver,2015; Lee, O'Keefe, Oh, & Han, 2015; Lubell, Jasny, & Hastings, 2016; McLeod, Hine, Please, & Driver,2015; Santo, Sorice, Donlan, Franck, & Anderson, 2015; Seekamp, McCreary, Mayer, Zack,

Charlebois, & Pasternak, 2016; Shaw, Howell, & Genskow, 2014). In the context of broad-scale AIS management, human-centered preventive approaches often take the form of public awareness and outreach campaigns that use informational strategies as indirect, passive persuasion tools to influence user behavior. For example, natural resource management agencies in Texas employ the Clean, Drain, and Dry™ (CDD) campaign as a mode of AIS public outreach and awareness throughout the state. The campaign targets recreational boaters and anglers with messages containing information and/or an appeal to clean, drain, and dry their boats, trailers, and gear before traveling from one lake or river to another.

Campaigns like CDD (e.g., Stop Aquatic Hitchhikers! ™, Be A Hero—Transport Zero™) may increase knowledge of AIS and adoption of mitigation behaviors through the information provisioned in their messages (Larson, ,2011; Oele, Wagner, Mikulyuk, Seeley-Schreck, & Hauxwell, 2015; Seekamp et al. 2016). However, studies assessing to what extent AIS campaign information influences behavior are few, particularly those that do so with an experimental design, which enables researchers to control for the information individuals receive (Lee et al., 2015). Research also suggests awareness and outreach campaigns can be more effective at influencing behavior if messages draw on broader social, moral, normative, affective, or cost/benefit aspects that alleviate information-deficit issues, i.e., possessing information not leading to behavior (Bell, 2005; Hine et al., 2015; McLeod et al., 2015; Sorice, Flamm, & McDonald, 2007; Steg & Vlek, 2009; Warner & Kinslow, 2011). For example, social norm messaging draws on normative social information to employ messages that state a majority or specific group

of users do a specific behavior or approve of those who do (Berkowitz, 2005; Goldstein, Cialdini, & Griskevicius, 2008; Schultz, 2002). Similarly, messages that references formal laws or regulations can be more effective in comparison to general information messages that do not reference broader social and contextual factors (Witte & Allen, 2000).

In Texas, CDD campaign materials and various print information are distributed at gas stations, bait shops, with billboards, signs, and other signage installed at public water access points throughout the state. While CDD messages provide general information that AIS are an issue in the state's public freshwaters and users need to engage in certain behaviors to mitigate the impacts of AIS, CDD message are not framed with information that focuses users on broader contextual aspects, e.g., social norms or formal regulations. With behavior change among resource users the goal of AIS awareness and outreach, management agencies can use relevant psychological and communication theory to develop and assess campaign messages. Using a statewide survey of registered boaters, this study draws on the framing and social norm messaging literature to modify Texas CDD campaign messages to examine if theory-based message framing influences Texas boaters AIS mitigation behavior intentions (Cialdini, Demaine, Sagarin, Barrett, Rhoads, & Winter, 2006; Chong & Druckman, 2007; Goldstein et al. 2008; Tversky & Kahneman, 1981; White, MacDonnell, & Dahl, 2011).

Literature review

Framing and messaging

The form of information, i.e., how it is structured or organized, and the medium it is communicated through is often referred to as a frame. As a communication device, a frame is used to create, organize, limit, or fix individuals on relevant or broader information or meaning, as individuals tend to respond differently to different but objectively equivalent information (Levin, 1998; Payne, 2001). Framing refers to the process by which individuals develop a particular conceptualization or reorient their thinking about an issue or scenario presented in a certain frame (Chong & Druckman, 2007). That is, framing is a process of selection and salience (Hallahan, 1999). This phenomenon of how the form of information effects subsequent behavior is referred to as a framing effect (Tversky & Kahneman, 1981).Valence framing, for instance, which refers to information framed in the form of an action resulting in gain or loss, elicits one of the most empirically supported and replicated framing effects (Klein et al., 2014). Information presented in the form of gains is often risk-averse, while loss is often risk-taking. That is, information framed as "you will gain X, if you do Y" versus "you will lose X, if you do not do Y" tends influence behavior to a greater degree when outcomes are relatively certain and the latter when uncertain.

In the context of biological invasion and prevention management, investigations of framing effects in the context of outreach and awareness messaging, are limited (Lee et al., 2015; Otieno, Spada, Liebler, Ludemann, Deil, & Renkl, 2014; Warner & Kinslow, 2011). Invasive species messaging primarily employ risk as a framing device,

similar to valence framing. For example, Otieno et al. (2014) and Warner and Kinslow (2011) focused on framing messages with risk/emotion and risk/values, respectively, whereas Lee et al. (2015) used proenvironmental and economic loss frames. With AIS prevention management contingent and focused on the collective actions or resource user, and message frames referencing formal (law) or informal (social norm) obligations may be suitable (Hine et al., 2015).

Regulation and formal law message framing

Messages that reference formal laws, regulations, or sanctions associated with doing or not doing a behavior can be effective at encouraging desired behaviors. This message frame is designed to increase the salience of broader societal/contextual factors such as a fine, ticket, legal action, etc., to deter undesired behavior by specifying possible personal hardship that can be incurred (Witte & Allen, 2000). For example, Gramann et al. (1995) observed participants receiving a message informing them of probable sanctions for rule violation were more likely to intend to obey regulations compared to those who did not receive that message.

In the context of natural resource management and recreation, the success of messages using a regulation frame have varied across context. Hunt and Hosegood (2008), in the context of vehicle access to public lands, found signs referencing federal regulations restricting vehicle access were effective at limiting traffic. Johnson and Swearingen (1992) and Martin (1992) observed sign with messages referencing sanctions or fines increased compliant behavior in the context of off-trail hiking and

vandalism, respectively, in public lands. However, others have found regulation-based messages to be ineffective at deterring undesired behavior. Duncan and Martin (2002), in the context of outdoor recreation, observed messages framed with a statement indicating a two-hundred and fifty dollar fine did not differ significantly from a general information message. In the context of recreational boating and adherence to speed limits, Sorice et al. (2007) found messages referencing the five-hundred dollar fine associated with speeding did not increase boaters' compliance in comparison to a message that only asked boaters to slow down.

Normative social information and social norm message framing

Normative social information refers to information the references a social norm, which is an informal rule or standard of common or approved behavior for a particular situation (Cialdini, 2012; Deutsch & Gerard, 1955). Normative social information can be communicated in two forms: *descriptive* information references what behavior is common or typical and *injunctive* information what behavior is expected or approved (Cialdini, 2012). Descriptive information provides individuals with social proof, i.e., evidence of what behavior is common or typical and, therefore, likely effective. Injunctive information provides evidence about what behavior likely confers social approval or avoids social disapproval (Cialdini, 2007; Winter et al., 2000).

A substantial amount of research has supported the influence these two forms of normative social information have on behavior. The focus theory of normative conduct, which posits these two forms of normative social information motivate behavior most

effectively when made salient, has found empirical support in various contexts (Cialdini, 2012). For example, injunctive information has been found to be effective at reducing undesirable behavior or influencing more desirable, prosocial behavior, particularly in contexts where an undesirable (antisocial) behavior is more common (Cialdini, 2006). Descriptive information is also demonstrated to significantly influence behavior, particularly in novel situations or when injunctive information is lacking (Bicchieri & Xiao, 2009; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Perceiving and being influenced by these two forms of normative social information does not necessarily require direct observation of others' behavior (Miller & Prentice, 1996; Perkins & Berkowitz, 1986). A large body of research incorporating normative social information into message framing in real world settings stems from this assumption (Berkowitz, 2005; Goldstein et al., 2008; Miller & Prentice, 2016).

The effectiveness of messages based on focus theory have empirical support within the conservation, proenvironmental, and sustainability literature (Gifford & Nilsson, 2014; Miller & Prentice, 2016; Newell, McDonald, Brewer, & Hayes, 2014). For example, de Groot et al. (2013) reduced plastic bag usage by including an injunctive norm in their messaging aimed at shoppers. Similarly, van der Linden et al. (2015) observed the largest reduction in plastic bottle usage in the experimental condition that combined persuasive messaging with a social norm. Cialdini et al. (2006) highlight the different effects descriptive and injunctive information frames have on behavior. That is, framing messages with descriptive information indicating many people did an undesired

behavior increased that behavior, whereas a message framed with injunctive information indicating an undesired behavior was disapproved reduced the behavior.

The efficacy of social norm message framing, while evidenced in various contexts, is not without limitation. For example, replications of social norm messaging experiments have garnered mixed results (Scheibehenne, Jamil, & Wagenmakers, 2016). Whereas Goldstein et al. (2008), Schultz et al. (2008), and Terrier and Marfaing (2015) demonstrate the effectiveness of social norm messages to increase sustainable behavior, Mair and Bergin-Seers (2010) and Bohner and Schlüter (2014) were unable to replicate those results in a similar context. The issues raised by these studies suggest inclusion of additional covariates are needed to evaluate the efficacy of social norm messaging (Schultz, Messina, Tronu, Limas, Gupta, & Estrada, 2014).

Personal norms

Personal norms, internal, moral standards of behavior one holds for oneself (Schwartz, 1973), can attenuate the influence of normative social information (Hopper & Nielsen, 1991; Wenzel, 2004). That is, strong personal norms are also thought to be followed regardless of additional types of information, as individuals already have an internal motivation to engage in a behavior (Göckeritz et al., 2010). For example, Bertoldo and Castro (2016) found that recycling behaviors were better predicted by personal norms than social norms. Similarly, Schultz et al. (2014) observed individuals with strong personal norms were less affected by social norms messages in comparison to individuals with weak personal norms. That is, as an additional explanatory variable,

personal norms tends to increase the variance explained related to behavior or intention within models with social norms as explanatory variables (Biel & Thøgersen, 2007). As such, we include personal norms as a covariate to control for their influence across message frames (de Groot et al., 2013; Nordlund & Garvill, 2003).

Present study

Human-centered biological invasion research is becoming more widespread and essential to managerial decision-making and policy development (Cottet, Piola, Le Lay, Rouifed, & Rivière-Honegger, 2015; Drake, Mercader, Dobson, & Mandrak, 2015; Kelly et al., 2013; Leung, Bossenbroek, & Lodge, 2006; Marzano, Dandy, Bayliss, Porth, & Potter, 2015; Moon, Blackman, & Brewer, 2015; Seekamp et al., 2016). In the context of aquatic invasives, studies investigating framing effects elicited by outreach and awareness messages are limited (Lee et al., 2015; Moon et al., 2015; Otieno et al., 2014). Message framing provides biological invasions management with a human-centered, theory-based tool capable of integrating with existing public awareness and outreach campaigns focusing on prevention and user behavior.

Given the social and public context of boating, AIS management may benefit from framing messages with normative social information. Likewise, appeals that reference formal regulations and fines align with state laws prescribing AIS mitigation behaviors (Parks & Wildlife Code § 66.0072 2011). As such, the purpose of this investigation is to employ a between-subjects experimental design to examine the effect general information, regulation, descriptive, and injunctive message frames have on

licensed Texas boaters' CDD behavior intention. While controlling for personal norms, we hypothesize participants receiving messages with normative social information will report significantly higher intention to engage in CDD (H1); participants receiving a regulation message will report significantly higher levels of intention in comparison to general information (H2); and descriptive and injunctive information conditions will not differ significantly in terms of intention (H3).

Methods

Participants

An online questionnaire was administered to a random sample of licensed Texas boaters to examine perceptions of invasive species, management practices, and mitigation behavior in public freshwaters (n = 9,500). Participants were solicited via email and provided a link to the questionnaire, which was administered through the web-based Qualtrics platform (Qualtrics, 2016). Following tailored design protocols, participants were contacted via email up to five times, approximately one week apart, until participants completed or opted-out (Dillman, Smyth, & Christian, 2014). After accounting for undeliverable emails and voluntary opt-outs, 8,609 participants received an invitation, with 2,324 questionnaires completed or partially completed (27% effective response rate). After data cleaning procedures, 1,780 usable questionnaires were include the study.

Table 4. Socio-demographic characteristics of Texas licensed boater sample (n = 1780).

	Percent
Gender	
Female	10.1
Male	89.9
Race	
American Indian/Native	0.9
Asian	0.4
Black/African American	1.1
Hawaiian/ Pacific Islander	0.2
White	93.9
Other	3.6
Ethnicity	
Hispanic, Latino/a	7.0
Education	
Less than high school	0.7
High school graduate	21.0
Vocational/trade school	7.4
Two-year college degree	17.5
Four-year college degree	35.0
Graduate degree	18.3
Income (gross household)	
Under $20,000	1.6
$20,000–$39,999	3.9
$40,000–$59,999	8.8
$60,000–$79,999	10.3
$80,000–$99,999	11.3
$100,000–$119,999	14.9
$120,000–$139,999	10.2
$140,000–$159,999	7.1
$160,000 +	31.9
Age (M, SD)	56.3 (11.71)

Materials

Participants were asked to self-report their awareness of AIS in Texas and CDD behaviors over the past 12 months. Awareness and was measured by asking participants (a) "how knowledgeable were you about the presences of aquatic invasive species in

Texas freshwaters", (b) "how aware were you of Texas state laws requiring boaters to clean gear and drain boat after using public waterbodies", (c) "how common are aquatic invasive species in Texas freshwaters", measured as 1 (not at all), 2 (somewhat) and 3 (very). Past behavior was measured on a scale of 1 (never) to 5 (always): (a) "cleaned my boat, gear, and trailer and removed any mud, plants, and animals before transporting my boat to another public waterbody", (b) "washed my boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody", (c) "drained all water from my livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody", and (d) "dried my boat and trailer for at least 7-10 days before launching into other public waters."

Participants were asked to report their personal norms toward AIS and CDD measured on an agreement scale of 1 (strongly disagree) to 5 (strongly agree) for the following items: "I feel a personal obligation to help reduce aquatic invasive species in Texas", "I feel morally obliged to help stop the spread of aquatic invasive species in Texas, regardless of what others do", "I feel guilty when I do not do Clean, Drain, Dry behaviors", "People like me should do whatever they can to stop the spread of aquatic invasive species in Texas" (adapted from Steg, Dreijerink, & Abrahamse, 2005). Participants were also asked to indicate on a 1–5 scale (strongly disagree–strongly agree) the extent to which seven conditions keep them from doing CDD: (a) boat ramps are too crowded, (b) there are no cleaning stations to do CDD, (c) I am rushed, too tired, or have no after boating, (d) I do not know what AIS to look for, (e) I do not have the ability to

do CDD, (f) I do not think CDD will slow the spread of AIS, and (g) I do not think CDD behaviors are effective.

The design and message frames associated with each condition were derived from several CCD campaigns implements by state and federal agencies in Texas. Each image was composed of three parts: the bottom half of the image stated the standard CDD message, “Clean, Drain, & Dry your boat, trailer, and gear every time”; the top half of the image reflected the primary message framing; and the middle section contained a smaller, secondary message in alignment with the design of the CDD campaign. The information condition’s primary message stated, “Don’t be a Carrier for Aquatic Invasives”, with the secondary message stating, “Stop the Spread.” The regulation condition’s primary message stated, “It’s the Law”, with the secondary message stating, “Fines up to $500.” The descriptive condition’s primary message stated, “Most Texans Clean, Drain, & Dry”, with the secondary message stating, “85% of Boaters.” The injunctive condition stated, “Texans Expect you to Clean, Drain, Dry”, with the secondary message stating, “Texas Approved.”

Participants behavioral intentions were measured with, “Based on the message you have just read, if you saw this message on signs or billboards around the Texas lakes and reservoirs, how likely are you to do the following Clean, Drain, Dry behaviors the next time you go boating?” Participants indicated their intention engage AIS mitigation behaviors on a scale of 1–5 (extremely unlikely–extremely likely) for five items worded similarly to those of current behavior. Socio-demographics were measured using a suite of questions related to age, gender, race, ethnicity, education, and income.

Figure 4. Design and message framing of clean, drain, and dry campaign material developed for study treatment conditions: (a) information, (b) regulation, (c) descriptive, (d) injunctive.

Procedure

Participants first answered questions pertaining to their awareness and personal norms towards AIS and the CDD campaigns. Participants were then asked to self-report

their CDD behavior. Next, to test our hypotheses, the Qualtrics software randomly assigned participants to one of four message framing conditions: information, regulatory, descriptive, and injunctive. Participants were then shown the corresponding CDD campaign image designed to reflect the message frame of each condition. Participants then indicated their behavioral intention. Finally, participants answered questions related to perceived behavioral barriers and questions about themselves (e.g., age, education, household income, etc.).

Results

Boater characteristics

The sample of Texas boaters ranged from age 19–85 (M = 56.3), was primarily male (89.9%) and white (93.9% white). A majority of the sample self-reported having a four-year college degree or above (53.3%) and a gross annual income of US$100,000 or above (64.1%). A complete summary of participants' socio-demographic data is reported in Table 1. All analyses were conducted using the statistical software package Statistical Package for the Social Sciences (SPSS, Version 21.0).

Participants' self-reported awareness of AIS reveal a majority of sampled boaters were somewhat knowledgeable of AIS presence in Texas (63.7%, M = 2.24), consider themselves very aware of Texas law (68.7%, M = 2.63), and a believe AIS to be somewhat common in Texas (54.8%, M = 2.40). Past behavior items did not differ across condition (information: $\chi^2 = 8.16$, $p = 0.77$; regulation: $\chi^2 = 7.87$, $p = 0.80$; descriptive: $\chi^2 = 8.04$, $p = 0.78$; injunctive: $\chi^2 = 6.67$, $p = 0.88$,). Participants' responses

indicate a relatively high frequency of past clean, drain, and dry behavior (M = 4.13; 4.33; 4.03) but washing was significantly reported less often (M = 3.64; clean: $t = 18.57$, $p < 0.000$; drain: $t = 22.81$, $p < 0.000$; dry: $t = 11.84$, $p < 0.000$) (Table 2). Personal norms items did not differ across condition (information: $\chi^2 = 15.28$, $p = 0.23$; regulation: $\chi^2 = 11.10$, $p = 0.52$; descriptive: $\chi^2 = 17.71$, $p = 0.13$; injunctive: $\chi^2 = 6.20$, $p = 0.91$,). Items measuring personal obligation were observed to be relatively high (M = 4.47; 4.46; 4.53) but the item measuring guilt was, on average, significantly lower(M = 3.93) (Table 2). Respondents' perceived behavioral barriers to the adoption of CDD did not differ across condition but variation among behaviors was observed, with barriers related to a belief that CDD will not slow AIS (M = 3.14) and crowding (M = 2.85) being significantly higher (Table 2, 5).

Table 5. Construct reliability, mean values, and frequencies for past behavior and personal norms related and mean values and frequencies for perceived barriers to CDD behaviors.

	Mean	SD	Frequencies (%)				
			1	2	3	4	5
Past behavior ($\alpha = 0.89$) [1]							
Drained all water from my livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody	4.33	1.39	12.7	2.5	0.9	6.3	77.6
Cleaned my boat, gear, and trailer and removed any mud, plants, and animals before transporting my boat to another public waterbody	4.13	1.48	15.2	3.7	1.4	12.2	67.5
Dried my boat and trailer for at least 7-10 days before launching into other public waters	4.03	1.51	15.5	5.5	2.1	13.3	63.6
Washed my boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody	3.64	1.67	22.6	8.3	3.3	14.3	51.4
Personal norms ($\alpha = 0.89$) [2]							
People like me should do whatever they can to stop the spread of aquatic invasive species in Texas	4.53	0.64	0.7	0.2	4.1	36.0	59.1
I feel a personal obligation to help reduce aquatic invasive species in Texas	4.47	0.70	0.9	0.5	5.8	37.4	55.4
I feel morally obliged to help stop the spread of aquatic invasive species in Texas, regardless of what others do	4.46	0.74	1.1	0.5	7.2	38.4	56.4
I feel guilty when I do not do Clean, Drain, Dry behaviors	3.93	1.00	2.9	3.7	28.2	29.7	35.5
Perceived behavior barriers [2]							
I do not think CDD will slow the spread of AIS	3.14	1.22	11.7	19.3	26.7	28.1	14.3
Boat ramps are too crowded	2.85	1.17	14.7	26.0	25.9	26.2	7.2
There are no cleaning stations to do CDD	2.26	1.02	25.3	39.0	22.3	11.4	2.0
I do not know what AIS to look for	2.50	1.11	20.2	35.1	22.8	18.4	3.5
I do not think CDD behaviors are effective	1.91	0.98	40.3	38.2	14.3	4.7	2.5
I am rushed, too tired, or have no after boating	1.90	1.03	42.9	36.9	11.3	5.5	3.4
I do not have the ability to do CDD	1.82	0.94	44.2	37.5	12.1	4.0	2.1

[1] Scale: never = 1, sometimes = 2, about half the time = 3, most of the time = 4, always = 5

[2] Scale: strongly disagree = 1, disagree = 2, neither agree nor disagree = 3, agree = 4, strongly agree = 5

Message framing effects and boater behavior intention

We used a one-way analysis of covariance procedure (ANCOVA) to test our hypotheses that boaters' intention to engage in CDD will vary based on message framing while controlling for personal norms. Prior to conducting our primary analysis, we tested our randomization procedure. We observed no differences by condition with regard sociodemographic and behavioral indicators: gender ($\chi^2 = 6.25$, $p = 0.10$, Cramer's $V = 0.06$), gross household income ($\chi^2 = 23.58$, $p = 0.49$, Cramer's $V = 0.07$), education ($\chi^2 = 6.39$, $p = 0.97$, Cramer's $V = 0.03$), frequency of boating ($\chi^2 = 9.59$, $p = 0.85$, Cramer's $V = 0.05$), and region most often boated ($\chi^2 = 17.37$, $p = 0.50$, Cramer's $V = 0.06$).

Next, ANCOVA assumptions were tested (Rutherford, 2011). Independence of observations was maintained given different participants were assigned to each group and no participant was in more than one group. Intention ($M = 4.36$) and personal norm ($M = 4.41$) were converted to a single variables to meet the assumption that the dependent variable and covariate are continuous. The covariate was observed to be linearly related to the dependent variable at each level of the independent variable (i.e., parallel lines). Homogeneity of regression ($F = 0.93$, $p > 0.05$) was not statistically significant. Homogeneity of variances ($F = 3.26$, $p < .05$) was statistically significant. Residuals were observed to be non-normally distributed ($D = 0.18$, $p < 0.001$). Visual inspection of associated histograms and Q-Q plots concluded this was as an artifact of a large sample size and our main analysis was enacted (Howell 2013).

Results from omnibus ANCOVA F-test indicated a significant main effect of the treatment conditions on the outcome measure of intention while accounting for variation

in personal norms (F = 6.39, p < 0.001; Table 3). The effect size of message condition on the dependent variable was weak ($\eta p^2 = 0.01$) while the effect size of the covariate was moderate, explaining approximately 11% of the variance in behavioral intention ($\eta p^2 = 0.11$). Pairwise post-hoc testing revealed participants' mean intention was differed significantly by condition (Table 7). Participants in the regulation condition reported greater mean intention (M = 4.52, SD = 0.81) compared to information (M= 4.38), 0.83; F = 8.48, p < 0.01), descriptive (M = 4.34, 0.89; F = 18.05, p < 0.001), and injunctive conditions (M = 4.40, 0.83; F = 6.74, p < 0.01 (Table 4). These results do not support Hypothesis 1. Hypothesis 2 was supported, mean intention in the regulatory condition was significantly greater than the information condition. No significant difference was observed between descriptive and injunctive conditions in terms of mean intention, supporting Hypothesis 3.

Table 6. Intention by treatment with personal norm covariate ANCOVA with selected cases.

Message group	Intention				
	Observed mean	SD	Adjusted mean	SE	n
Information	4.38	.83	4.39	.038	449
Regulation	4.52	.81	4.54	.036	482
Descriptive	4.34	.89	4.32	.037	450
Injunctive	4.40	.83	4.40	.040	399
Source	SS	df	MS	F	ηp^2
Personal norm	140.26	1	140.26	222.07***	.11
Message condition	12.11	3	4.04	6.39***	.01
Error	1121.12	1775	.61		

Note: R^2=0.12, Adj. R^2=0.12, adjustments based on personal norm mean=4.35. Personal norm regression coefficient=0.43. Independence of factor and covariate, *F*=1.04, p>.05. Homogeneity of regression, *F*=0.93, p>.05. Levene's test of homogeneity of variance, *F*=3.26, p<.05.
***p<.001

Table 7. Post-hoc pairwise comparisons based on estimated marginal means.

Comparisons	Mean difference	Std. error	F	95% CI
Information vs. Regulation**	.152	.052	8.48	.050, .254
Information vs. Descriptive	-.070	.053	1.74	-.174, .034
Information vs. Injunctive	.012	.055	.05	-.095, .119
Regulation vs. Descriptive***	-.222	.052	18.05	-.324, -.119
Regulation vs. Injunctive**	-.140	.054	6.74	-.245, -.034
Descriptive vs. Injunctive	.082	.055	2.25	-.025, .189

Note: ** p<.01, ***p<.001

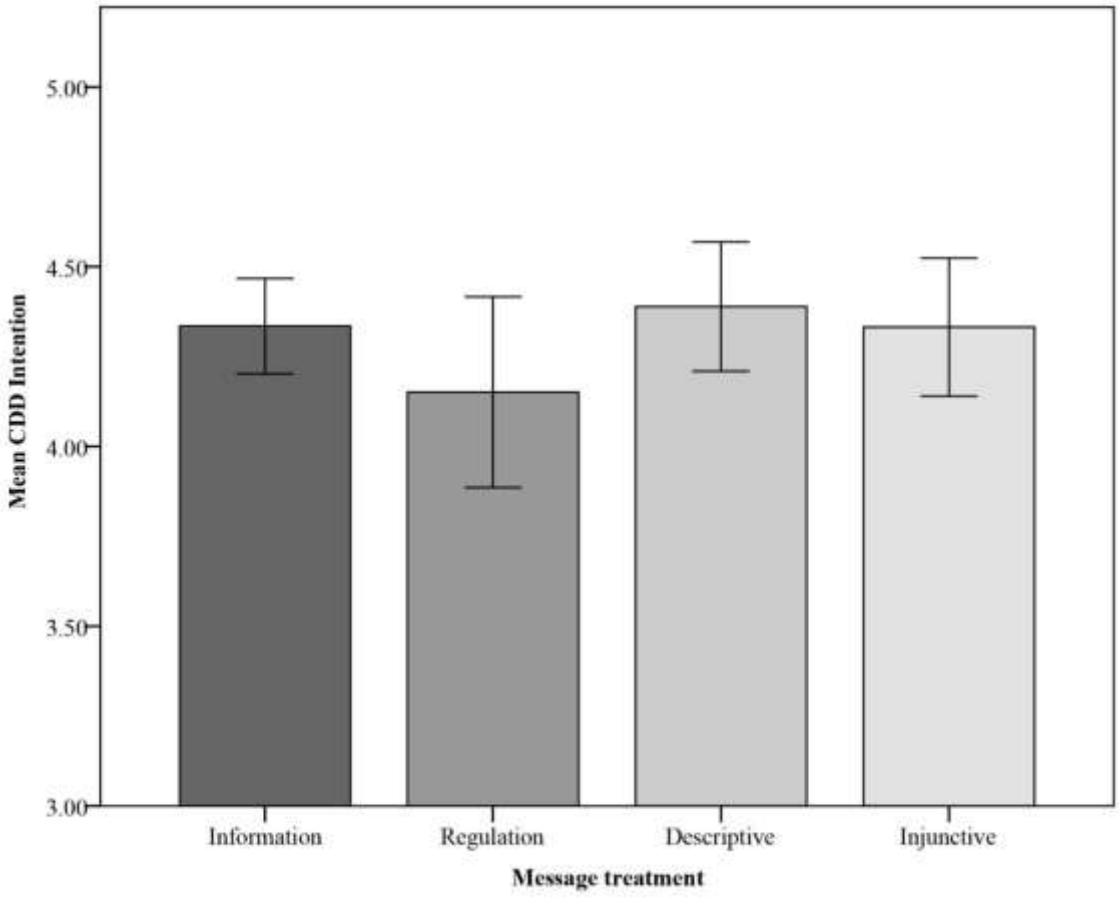

Figure 5. Bar chart of dependent variable (intention) across study treatment conditions.

Discussion

The purpose of this investigation was to examine how different message frames affect boaters' intention to engage in AIS mitigation behaviors, specifically those related to CDD in Texas. Our results add to calls for increased human-centered biological invasion research and builds upon applied research demonstrating variation in the effectiveness of message framing and associated trends toward replication (Lakoff, 2010; McLeod et al., 2015; Open Science Collaboration, 2015; Scheibehenne et al., 2016). Overall, our main analysis did not reveal significant differences among message conditions while controlling for personal norms. Consistent with our hypothesis, participants receiving messages with descriptive and injunctive information did not differ significantly from one another. However, participants receiving messages framed with normative social information did not report significantly different and higher intention to engage in CDD. Participants receiving the regulation frame message did not report significantly different or higher levels of intention compared to a general information message. These findings align with past studies observing mixed results regarding messages framed with normative social and regulation information in applied settings.

Past research suggests social norm messages are effective when descriptive information highlights the prevalence of a desired behavior or an injunctive information highlights approval of desired behavior or disapproval of undesired behavior (Cialdini et al., 2006; Winter et al., 2000). Our study attempted to mimic these conditions. As anticipated, the conditions using descriptive information to frame the desired CDD

behaviors as common and injunctive information to frame them as approved did not differ significantly. However, the main effect of message frame condition and post-hoc analyses adds to the body of literature of ambiguous findings related to message framing in applied pro-environmental and natural resource settings (Scheibehenne et al., 2016). A possible explanation for our results is that the assumption of salience was not met, as several factors can affect if an individual perceives and focuses normative social information and is subsequently influenced by it (Cialdini, 2012). Our analysis sought to control for one such factor, personal norms; with results suggesting personal norms are an important consideration and provide additional statistical control. This aligned with previous research suggesting social norms exerts less influence on individuals with strong personal norms (which the majority of our sample possessed), assuming the individual already holds a strong internal motivation to engage in a behavior and external social motivation is unlikely to provide more (Göckeritz et al., 2010; Schultz et al., 2014).

The assumption to messages framed with references to formal laws and associated fines or sanctions is that they make salient the consequences of noncompliance, which can increase compliance. That is, a regulation frame provides explicit information about the consequences of *not* doing a behavior. Past studies in recreational contexts suggest messages framed using fear appeals (e.g., emphasizing fines for rule breaking) increase compliance (Gramann et al., 1995; Witte & Allen, 2000). However, reference to state law and a fine resulted in the lowest level of intention. Like social norm messaging, these results and to a mixed body of literature.

Applied implications

In terms of applied implications for the management of biological invasions, not observing significant differences between message conditions provides insights that can be useful to management. In particular, intention was lowest in the regulation condition but participants report high levels of awareness of state AIS laws, which suggests issues of monitoring and enforcement may be confounding the effectiveness of this message frame. That is, there is a difference between being aware of the law and complying with it. The effectiveness of regulation message frames to increase compliance may correlate with boaters' belief of or experience with enforcement. Objectively, there is a difference between knowing it is the law and knowing you will get caught being non-compliant with that law. Unfortunately, our questionnaire did not ask any question pertaining to participants being inspected and ticketed themselves or observe it happen to other boaters. Generalizing these results to contexts where similar AIS laws exist, framing messages to focus boaters on aspects of monitoring and enforcement, rather than laws and associated fines, and coupling this with on-the-ground efforts and evidence of monitoring and enforcement (e.g., law enforcement presence, management presence, inspection stations, surveillance, etc.) maybe be a more effective management strategy.

In relation to normative social information, these results should not dissuade management agencies from developing and implementing these message frames, particularly if formal regulations are not in place. In this situation, maintaining AIS mitigation behaviors via conformity (to informal social norms) rather than compliance (to formal laws) may be necessary (Cialdini & Goldstein, 2004). As a caveat,

management agencies may consider more systematic and structured frameworks to determine an appropriate message frame and their efficacy for a specific context, e.g., via focus groups and pilot tests (McKenzie-Mohr, 2011; McKenzie-Mohr & Schultz, 2014). Alternatively, the high levels of personal norms reported may direct management agencies towards personal norm or moral message framing (e.g., Feinberg & Willer, 2013; Lakoff, 2010). In the context of Texas AIS management, knowing that a majority of boaters have strong personal norms towards the desired CDD behaviors implies making personal norms salient may be an effective message frame that better aligns with existing population characteristics. For example, framing messages with personal obligation/responsibility to engage in AIS mitigation behaviors: "boaters like me care about public waters" or "boaters like me should do whatever they can to slow the spread of AIS."

Finally, message framing represents only one type of intervention strategy that can be implemented with public awareness and outreach programs. Past work suggests combined intervention strategies are more effective than standalones (Abrahamse et al., 2005; Osbaldiston & Schott, 2012). Developing messaging strategies in conjunction with other strategies and techniques may increase the efficacy of public outreach and awareness campaigns attempting to influence user behavior (Abrahamse & Steg, 2013). For example coupling the occasional presence of management personnel (for monitoring and enforcement) with various physical interventions (stoplights at public access pullouts or draining/washing stations) and messaging campaigns that are appropriately framed may, ultimately, be the most effective broad-scale management strategy.

4. EXAMINING THE RELATIONSHIP BETWEEN NORMATIVE SOCIAL BELIEFS AND SOCIAL COMPARISON PROCESSES IN AN APPLIED NATURAL RESOURCE SETTING

Introduction

Effective natural resource management relies on resource users to engage in behaviors that mitigate negative and/or enhance positive environmental impacts. With behavior focal, theories from social psychology and related behavioral science disciplines can inform understanding of human behavior and decision-making processes in natural resource management contexts (Gifford, 2014). Increased understanding of the relationships among internal cognitive factors antecedent to behavior provides management agencies with insight into, for example, user responses to outreach and education activities or support of management practices and policy initiatives (Heberlein, 2012; Newell, McDonald, Brewer, & Hayes, 2014).

While the theoretical (dis)association between various cognitive constructs are empirically supported (e.g., attitudes, values), questions remain about the relationships among and pathways by which other social and dispositional variables affect resource user (in)action in applied settings (Steg & Vlek, 2009). For instance, research suggests incorporating variables measuring perceptions of social context and responses to those perceptions are necessary for a fuller understanding of social influences on individual behavior (McKenzie-Mohr & Schultz, 2014; Schultz, 2011). This stems, partially, from the value-action gap (Blake, 1999; Kollmus & Agyeman, 2002) and information deficit

model literature (Bell, 2005; Schultz, 2002), which suggest behavior models that incorporate antecedent variables and relationships more closely associated with perceptions and reactions to social context may be more predictive of behavior (Steg & Vlek, 2009).

Normative social beliefs—beliefs about the behaviors others do and/or approve—reflect a perception of social context (Berkowitz, 2005; Cialdini, Kallgren, & Reno, 1991; Göckeritz, Schultz, Rendon, Cialdini, Goldstein, & Griskevicius, 2010; Perkins, 2003). The salience of social beliefs (i.e., how focal or well perceived), particularly those that pertain to how common/typical (descriptive belief) or approved/accepted (injunctive belief) a behavior is within a social group, can influence behaviors (Nolan, 2016; Schultz, Tabanico, & Rendón, 2008). In general, normative social beliefs are shown to influence behavior that is enacted in both public and private domains (Delmas & Lessem, 2014; Goldstein, Cialdini, & Griskevicius, 2008; Niemiec, Ardoin, Wharton, & Asner, 2016; Thøgersen & Biel, 2007; Xenitidou & Edmonds, 2014). The relationship between normative social beliefs and behavior is often contingent on and facilitated by an individuals' tendency to socially compare (Festinger, 1954; Gibbons & Buunk, 1999). Two theorized social comparison constructs that potentially influence the relationship between normative social beliefs and behavior are self-monitoring, the extent to which an individual to regulates their behavior to accommodate a given situation (Snyder, 1974), and concern for appropriateness, the extent to which an individual perceives and accommodates others' social (dis)approval of a behavior (Lennox & Wolke, 1984). These constructs reflect an individual's

tendency to perceive and react to others' behaviors and, subsequently, adjust their own based on social cues of a behavior (un)commonness or (dis)approval, which is a central element of normative beliefs' influence on behavior. However, applied studies examining the relationship between normative social beliefs and social comparison processes are limited.

In the present study, we examine the relationship between two dimensions of normative social beliefs, self-monitoring, and concern for appropriateness among licensed boaters in the context of self-reported behaviors intended to mitigate the spread of aquatic invasive species (AIS) in Texas. We ask, how does an individual's tendency to engage in social comparison influence behavior and the relationship between normative social beliefs and behavior? Over the past decade, normative social beliefs and associated social norm research have become a popular framework to understand social-cognitive factors that influence behavior within public natural resource management settings (Abrahamse & Steg, 2013; Miller & Prentice, 2016). We build on this literature by exploring social comparison processes and normative social beliefs in an applied setting.

Literature review

Normative social beliefs

Often used synonymously with the term social norm, a normative social belief is a distinct but related concept. A social norm refers the actual state of a behavior's prevalence or acceptance (approval or expectation), whereas a normative social belief

refers to an individual's perceptions of that prevalence or acceptance within a particular social context (Nolan, 2011; Schultz et al., 2008). As with other types of beliefs, normative social beliefs refer to an internal cognitive construct or mental representation of the external social norm, and like other mental states, normative social beliefs play an important role in decision-making processes and can vary from person to person (Miller & Prentice, 2016; Monin & Norton, 2003).

Normative social beliefs are categorized into two distinct dimensions, descriptive and injunctive, with each having independent motivational sources (Cialdini, Reno, & Kallgren, 1990). Descriptive beliefs refer to an individual's mental representation of how typical or common a behavior is, representing a belief about what behavior is done or not. Descriptive beliefs motivate behavior because observing or perceiving what others do in a particular situation provides social proof about what behavior is likely effective or adaptive (Cialdini, 2007; Berkowitz & Perkins, 1986). Injunctive beliefs refer to an individual's mental representation of what behavior is approved or appropriate, representing a belief about what behavior ought to be done or not (Cialdini et al., 1991). Injunctive beliefs motivate behavior because they reflect an understanding of the informal rules or guidelines of a social situation and associated social incentives, i.e., reward or punishment (Nolan, 2016). That is, whereas injunctive beliefs motivate behavior with a potential of acquiring or avoiding a social (dis)approval, descriptive beliefs motivate by providing evidence of what behavior is typical or sensible.

A number of studies observe a significant relationship between normative social beliefs and behavior (or intention) in several contexts: energy conservation (Göckeritz et

al., 2010), environmental protection (Wang & Lin, 2017), resource management (Colding & Folke, 2001), proenvironmental behaviors (Schultz et al., 2008; McDonald, Fielding, & Louis, 2013), and recycling (Nolan, 2011). Kallgren, Reno, and Cialdini (2000), in the context of public/private littering behavior, describe injunctive beliefs' influence on behavior as being associated with an individual seeking to acquire social approval or avoid social disapproval. Their findings suggest, though, that the relationship between normative social beliefs and behavior is dependent on the salience of those beliefs. Nolan, Schultz, Cialdini, Goldstein, and Griskevicius (2008) examined participants' descriptive beliefs about their neighbor's behavior and observed that these salient beliefs had the strongest effect on decisions to conserve energy in their own home. That is, believing that others engage in a particular behavior was positively associated with engaging or intending to engage the associated behavior (Cialdini, 2007; Miller & Prentice, 2016). Injunctive beliefs, likewise, have direct influence on behavior, but also reinforce the influence of descriptive beliefs (Göckeritz et al., 2010; Melnyk, van Herpen, Fischer, & van Trijp, 2011; Reno, Cialdini, & Kallgren, 2003;Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007).

While these findings assert normative social beliefs influence on behavior, questions remain as to how normative social beliefs directly or indirectly affect behavior, and the influence other explanatory variables may have. There are a limited number of studies modeling the direct and indirect relationships between both dimensions of normative social beliefs and behavior (Cialdini, 2003; Rimal, 2008; Rimal & Real, 2005; Schultz, Messina, Tronu, Limas, Gupta, & Estrada, 2014). For example, Rimal and Real

(2005) conceptualized a direct relationship between descriptive beliefs influence and behavior, with injunctive beliefs, outcome expectations, group identity acting as moderators that heighten the influence of descriptive beliefs. Their findings align previous work establish a significant main effect of descriptive beliefs on behavior (e.g., Berkowitz & Perkins, 1986) but found a significant interaction with the moderating variables, which explained an additional thirty-seven percent of the variance. Göckeritz et al. (2010) tested the moderating effect of injunctive beliefs on the relationship between descriptive beliefs and behavior, finding that this was strongest for individuals with high injunctive beliefs. In contrast, Cialdini (2003) conceptualized descriptive and injunctive elements as exogenous predictors of behavior, with descriptive elements directly influencing behavior and injunctive elements being mediated by evaluations of normative information. He observed both paths to be statistically significant. Collectively, these studies highlight the relationship between normative social beliefs and behavior can be conceptualized as being facilitated additional variables related to perceptions of social context. However, few studies have examined variables associated with individuals' perceptions and responses to social cues (i.e., signify commonness and/or appropriateness), which are likely to influence the salience and tendency of individuals to focus on normative social beliefs (Cialdini et al., 1990; Rimal & Lapinski, 2015).

Social comparison: self-monitoring and concern for appropriateness

The influence normative social beliefs have on behavior stems partly from an individual's tendency to compare their behavior to others (Cialdini et al., 1990, 1991). The theoretical tenets of social comparison suggest individuals make assessments about what behavior is adaptive or appropriate by comparing themselves to others (Festinger, 1954). Two theoretical concepts with developed measures that reflect aspects of social comparison are self-monitoring (Leone, 2006; Snyder, 1974) and concern for appropriateness (Lennox & Wolfe, 1984). These concepts represent a deliberate cognitive process of engaging in social comparison to determine, which may provide additional explanation as to why normative social beliefs influence behavior (Rimal & Lapinski, 2015). That is, a tendency to self-monitor and concern oneself with appropriate behavior can directly influence behavior, but may also indirectly influence behavior as a mediator **(**Rarick, Soldow, & Geizer, 1976**).**

Snyder (1974, 1983) defined the concept of self-monitoring as tendency to control ones' expressive behavior and self-presentation that is guided by situational cues of social appropriateness (i.e., an awareness of others' behavior and their reaction to ones' behavior). The concept of concern for appropriateness refers to an attentiveness to others' judgments that a behavior is socially appropriate or approved. Put differently, some individuals tend to behave in accordance with other's expectation because they are alert to subtle cues in their social environment (Briggs, Cheek, & Buss, 1980). The concept of concern for appropriateness stems from Lennox and Wolfe's (1984) analysis of the original self-monitoring scale (SMS) (1974). Initially, the SMS was assumed

unidimensional, but further analysis of its psychometric properties resulted in the revised self-monitoring scale (RSMS) and the concern for appropriateness scale (CAS) (Day, Schleicher, Unckless, & Hiller, 2002; Lennox, 1988). According to Lennox and Wolfe (1984), the RSMS (self-monitoring) constitutes a measure of acquisitive self-presentation and an individuals' desire to acquire social approval. The CAS measures protective self-presentation and the desire to avoid social disapproval (Johnson, 1989).

The direct and indirect relationship between self-monitoring and behavior has been examined in several contexts: social dilemmas (de Cremer, Snyder, & DeWitte, 2002), self-perception (DeMarree, Wheeler, & Petty, 2005), voting behavior (Girvan, Weaver, & Snyder, 2010), health behavior (Jang, 2012), social norms (Yun & Silk, 2011), and social identity (White, Smith, Terry, Greenslade, & McKimmie, 2009). Jang (2012) conceptualized self-monitoring as a moderator of descriptive beliefs and intention, observing a significant interaction, wherein with low self-monitoring individuals were more likely to be guided by normative beliefs compared to high self-monitors. In contrast, using a similar conceptualization, but only the attention to social comparison information (ASCI) sub-scale of the RSMS, Yun and Silk (2011) observed no significant interaction between ASCI and descriptive beliefs (neither study measured injunctive beliefs). In an experimental setting manipulating aspects of descriptive and injunctive beliefs, White et al. (2009) found no empirical support for relationship between self-monitoring and behavior. Kredentser, Fabrigar, Smith, and Fulton (2012), however, observed a significant interaction between injunctive information and self-

monitoring in an experimental setting, wherein increases in an individual's tendency to self-monitor were associated with lower intentions.

The CAS has not been widely used and we are not aware of studies using the CAS to examine the relationship between normative social beliefs and behavior in natural resource contexts (*cf.* Krupka & Weber, 2013). Yet, the concept implies individuals concern themselves with the appropriateness of their actions by comparing their actions with others, which relates to normative social beliefs concerning what behavior is perceived as appropriate or expected for a given situation (Spanos, Vartanian, Herman, & Polivy, 2015). Thus, it is likely a measure of this concern via the CAS will provide insights into the mechanism by which normative beliefs affect behavior (Johnson, 1989).

Study objectives and hypotheses

Cialdini et al. (1990) suggests that normative social beliefs are more likely to influence behavior when they are salient and focal. This implies individuals must perceive and process social cues from the surrounding environment that signify if a behavior is common and/or appropriate. As the literature review of self-monitoring and concern for appropriateness illustrates, these social comparison constructs are theorized as measures of individuals' tendency to discern social cues and compare their behavior with others in the same setting or group. While these aspects of social comparison may influence the relationship between normative social beliefs and behavior (Rimal & Lapinski, 2015), research examining these relationships is limited. This represent an area

of inquiry that can expand understanding of how normative influences and social comparison's effect on behavior, and also the mediating mechanisms through which normative social beliefs influence behavior (Fazio & Roskos-Ewoldsen, 2004; Kallgren et al., 2000; Wood & Stagner, 1994).

Thus, the purpose of this study is to examine the relationship between descriptive beliefs, injunctive beliefs, self-monitoring, concern for appropriateness, and self-reported behavior (Figure 2). We hypothesize that descriptive beliefs will have a significant and positive direct effect on self-reported behavior (H1a), self-monitoring (H1b), and concern for appropriateness (H1c). Likewise, injunctive beliefs will have a significant and positive direct effect on self-reported behavior (H2a), self-monitoring (H2b), and concern for appropriateness (H2c). We also hypothesize that self-monitoring will have a significant and positive direct effect on self-reported behavior (H3), as will concern for appropriateness (H4). We conceptualize self-monitoring and concern for appropriateness will be mediators of a deliberative belief-behavior cognitive process and, therefore, hypothesize significant positive indirect effects of normative beliefs and social comparison processes on self-reported behavior (H5, H6).

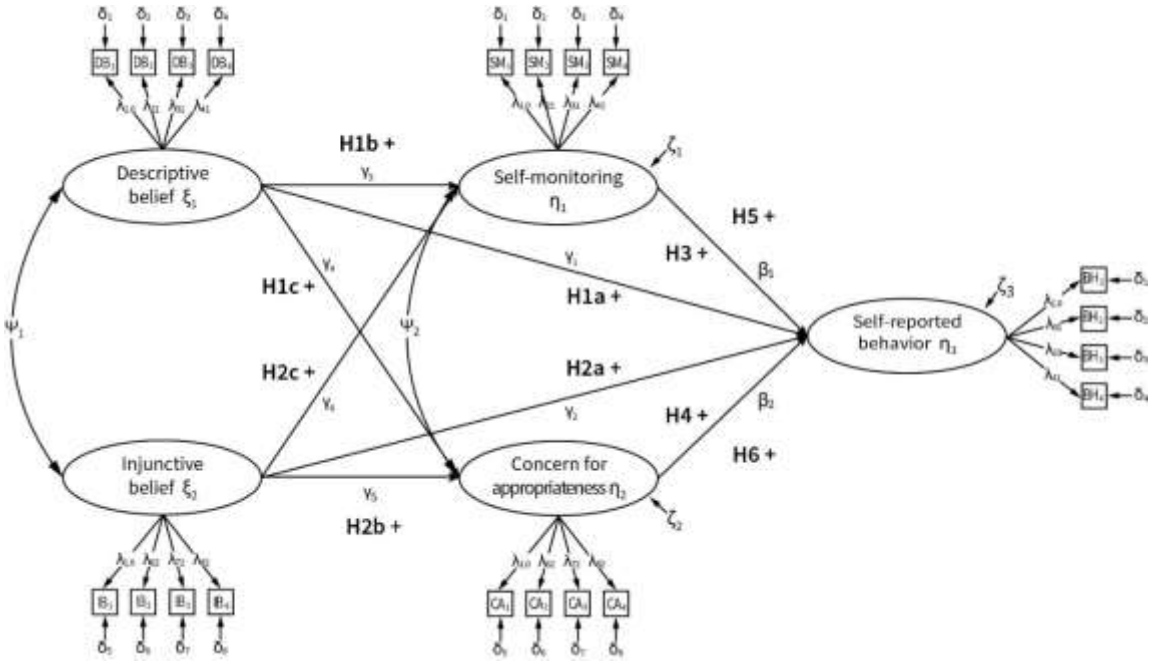

Figure 6. Hypothesized model of theoretical relationship between normative social beliefs, social comparison processes, and behavior.

Methods

Study context

The United States defines invasive species as non-native or alien species within the ecosystem under consideration "whose introduction does or is likely to cause economic or environmental harm or harm to human health" (Executive Order No. 13,112, 1999, p. 6183). Aquatic invasive species (AIS) are a major natural resource management concern within U.S. inland freshwater systems (McMichael & Bouma, 2000; U.S. Fish & Wildlife Service, 2012). Aquatic invasives threaten native species diversity, ecosystem stability, and/or commercial, agricultural, and recreational activities dependent on freshwater systems (U.S. Commission of Ocean Policy, 2004). In Texas,

AIS such as zebra mussel (*Dreissena polymorpha*), giant salvinia (*Salvinia molesta*), water hyacinth (*Eichornia crassipes*), water lettuce (*Pistia stratiotes*), and bighead carp (*Hypophthalmichthys nobilis*) are a significant management concern for the state of Texas. Exacerbating this concern are AIS within inland freshwaters frequented by resource users, specifically boaters, whose movement between waterbodies increases the potential for AIS to also move between waterbodies and establish elsewhere (Vander Zaden & Olden, 2008). That is, boaters who use and travel between multiple waterbodies, and who may or may not regularly or properly inspect and/or clean their boat or equipment for AIS, can act as a vector for AIS spread (Anderson, Rocliffe, Haddaway, & Dunn, 2015; Johnson, Ricciardi, & Carlton, 2001; Kelly, Wantola, Weisz, & Yan, 2013; Lee, O'Keefe, Oh, & Han, 2015).

Currently, Texas encourages AIS mitigation behaviors among boaters via a public awareness and outreach campaign, Clean, Drain, and Dry™ (CDD). This campaign provisions information and appeals to boaters, encouraging them to engage in the eponymous AIS mitigation behaviors after boating and before traveling to another waterbody. Similar to other AIS campaigns, CDD is designed to encourage behaviors at the waterbody (public) and home (private) (Connelly, Lauber, & Stedman, 2015; Lee et al., 2015; Niemiec, Ardoin, Wharton, & Asner, 2016; Oele, Wagner, Mikulyuk, Seeley-Schreck, Hauxwell, 2015; Seekamp, McCreary, Mayer, Zack, Charlebois, & Pasternak, 2016). In addition, Texas state laws establishes that boaters must engage in AIS mitigation behaviors immediately upon leaving a public or private waterbody or be subject to a financial fine for noncompliance (Parks & Wildlife Code § 66.0071, 2005).

The combination of the CDD campaign and established state law implies AIS and AIS mitigation behaviors are relevant to Texas boaters (data from the current study indicates the majority of Texas boaters are somewhat knowledgeable of AIS in Texas (63.7%), consider themselves very aware of the Texas law (68.7%), and believe AIS are somewhat common in Texas (54.8%)).

Participants

We sampled 9,500 licensed Texas boaters from an initial random selection of 10,000 (500 were randomly selected for pre-testing purposes). The sample was provided by the Texas Parks and Wildlife Department (TPWD), who retain a database of licensed boater, which includes email addresses. Following tailored design protocol, participants were contacted via email and provided a link to the questionnaire up to five times, approximately one week apart, until they completed the questionnaire, opted-out, or the survey time period expired (Dillman, Smyth, & Christian, 2014). Survey solicitation and questionnaire administration were completed using Qualtrics, an online survey research platform (Qualtrics, 2016), and protocols recommended by Dillman et al. (2014). After accounting for bounced emails and voluntary opt-outs, 8,609 participants received an invitation, with 2,324 questionnaires completed or partially completed (27% effective response rate).

Participants' ages ranged from 19-82, with a mean age of 55 (91.9% male, 8.1% female; 93.8% white; 6.0% Hispanic). Twenty-two percent reported high school as their highest level of education, 24.7% a vocational or two-year college degree, 35.1% a four-

year college degree, and 17.0% reporting a graduate degree. (<1% reported less than high school). A gross annual income of over $120,000 was reported by 49.4% of participants, 37.6% between $60,000-120,000 and 13.1% under $60,000.

Measures

Participants' self-reported the frequency of AIS mitigation behaviors (BH) over the past 12 months (1=never, 2=seldom, 3=occasionally, 4=often, 5=always) were measured on a 4-item formative scale: "over the past twelve months, I have," (1) cleaned my boat, gear, and trailer and removed any mud, plants, and animals before transporting my boat to another waterbody, (2) washed my boat and trailer (e.g., with a pressure washer or car wash) before traveling to another public waterbody, (3) drained all water from livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody, (4) dried my boat for at least 7-10 days before launching in other public waters.

Participants' descriptive beliefs (DB) were measured on a 4-item reflective scale adapted from Göckeritz et al. (2010; α=.82). The item stem asked participants to "indicate how often you believe other Texas boaters engage in Clean, Drain, Dry behaviors?" (1=never, 2=seldom, 3=occasionally, 4=often, 5=always). The scale consisted of the following four items: (1) clean their boat, gear, and trailer and remove any mud, plants, and animals before transporting their boat to another public waterbody, (2) wash their boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody, (3) drain all water from their livewell, bilge,

motor, and other receptacles that have been in contact with public waters before leaving that same waterbody, (4) dry their boat and trailer for at least 7-10 days before launching into other public waters. Injunctive beliefs (IB) were also measured on a 4-item reflective scale adapted from Göckeritz et al. (2010; α=.80). These items asked participants to indicate their level of agreement (1=strongly disagree–5=strongly agree) with statements preceded by the item stem "Other Texas boaters expect me to": (1) clean my boat, gear, and trailer and remove any mud, plants, and animals before transporting their boat to another public waterbody, 2) wash my boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody, 3) drain all water from my livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody, 4) dry my boat and trailer for at least 7-10 days before launching into other public waters.

Participants' level of self-monitoring (SM) was measured on 4-item reflective scale based on items from Lennox and Wolfe's RSMS (1984; α=.77; the four items were choose based on their linear correlation coefficient value). The 4-item scale asked participants to rate their level of agreement (1=strongly disagree–5=strongly agree) with the following items: 1) I can change my behavior if I feel something different is necessary based on what I see others' doing, 2) I can control how I come across to others depending on the impression I want to give, 3) I can adjust my Clean, Drain, Dry behaviors to meet the expectations of others, 4) I can change my behavior if the situation calls for something different. Participants' level of concern for appropriateness (CA) was measured on a 4-item reflective scale on the best performing items based on Lennox and

Wolfe's CAS (1984; α=.86; the four items were choose based on their linear correlation coefficient value). Our scale asked participants to rate their level of agreement (1=strongly disagree–5=strongly agree) for the following items: 1) if others are doing Clean, Drain, Dry it must be the appropriate action to take, 2) I look to others' behavior if I am uncertain of what behavior is appropriate, 3) I pay attention to others' reactions to my behaviors to avoid being out of place, 4) My behavior often depends on how I feel others think I should behave.

Table 8. Summary results of measurement model: confirmatory factor analysis, scale item descriptives, and reliability measures (n = 1,086).

		α	λ	*t*	M	SD
Descriptive belief (DB)		.90				
DB_1	Texas boaters clean their boat, gear, and trailer and remove any mud, plants, and animals before transporting their boat to another public waterbody		.94	—	3.18	.95
DB_2	Texas boaters wash their boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody		.85	42.52	2.98	1.01
DB_3	Texas boaters drain all water from their livewells, bilges, motors, and other receptacles that have been in contact with public waters before leaving that same waterbody		.86	40.46	3.39	.99
DB_4	Texas boaters dry their boat and trailer for at least 7-10 days before launching into other public waters		.82	37.63	3.02	1.04
Injunctive belief (IB)		.95				
IB_1	Texas boaters expect me to clean my boat, equipment, and trailers and remove any mud, plants, and animals before transporting my boat to another public waterbody		.96	—	4.00	.86
IB_2	Texas boaters expect me to wash my boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody		.95	66.63	3.87	.92
IB_3	Texas boaters expect me to drain all water from my livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody		.90	61.52	4.03	.90

Table 8 Continued. Summary results of measurement model: confirmatory factor analysis, scale item descriptives, and reliability measures (n = 1,086).

		α	λ	*t*	M	SD
IB_4	Texas boaters expect me to dry my boat and equipment for at least 7-10 days before launching in other public waters		.91	55.23	3.83	.98
Self-monitoring (SM)		.75				
SM_1	I can change my behavior if I feel something different is necessary based on what I see others' doing		.80	—	3.62	1.04
SM_2	I can control how I come across to others depending on the impression I want to give		.62	18.55	3.78	.96
SM_3	I can adjust my Clean, Drain, Dry behaviors to meet the expectations of others		.77	21.68	3.52	1.10
SM_4	I can change my behavior if the situation calls for something different		.60	18.66	4.00	.87
Concern for appropriateness		.74				
CA_1	If others are doing Clean, Drain, Dry it must be the appropriate action to take		.61	—	3.87	.91
CA_2	I look to others' behavior if I am uncertain of what behavior is appropriate		.79	14.64	3.03	1.12
CA_3	I pay attention to others' reactions to my behaviors to avoid being out of place		.75	14.58	2.96	1.14
CA_4	My behavior often depends on how I feel others think I should behave		.68	14.20	2.57	1.16
AIS behavior (BH)		.88				
BH_1	I have cleaned my boat, gear, and trailer and removed any mud, plants, and animals before transporting my boat to another public waterbody		.94	—	4.24	1.39
BH_2	I have washed my boat and trailer (for example, with a pressure washer or car wash) before traveling to another public waterbody		.86	32.86	3.71	1.63
BH_3	I have drained all water from my livewell, bilge, motor, and other receptacles that have been in contact with public waters before leaving that same waterbody		.92	42.39	4.42	1.29
BH_4	I have dried my boat and trailer for at least 7-10 days before launching into other public waters		.81	32.52	4.11	1.44

Goodness-of-fit indices: $\chi^2 = 1122.35$, df = 139, RMSEA = 0.08, CFI = 0.94, NNFI = 0.93, SRMR = 0.04

Results

All analyses were conducted in LISREL 9.20 using a Satorra–Bentler adjusted estimate for non-normal data (Jöreskog & Sörbom, 2015; Satorra & Bentler, 1994). Hypotheses were tested using a two-step structural equation modeling approach (Anderson & Gerbing, 1988). First, we tested the measurement properties of the items associated with each hypothesized latent constructs using confirmatory factor analysis (CFA), allowing the latent constructs to covary freely (Table 8). Next, our hypotheses were tested in our structural model which allowed the two normative belief constructs and two social comparison constructs to covary. We tested our hypotheses within a mediation framework to examine self-monitoring and concern for appropriateness in relation to the normative social beliefs and self-reported behavior relationship (Baron & Kenny, 1986). Model fit was assessed using a suite of indices (Kline, 2011): root mean square error of approximation (RMSEA) values between 0.06–0.08 indicate acceptable fit, with 0.10 considered an upper limit (Byrne, 2000; MacCallum, Browne & Sugawara, 1996), comparative fit index (CFI) $\geq$ 0.9 (Bentler, 1990), and standardized root mean square residual (SRMR) $\geq$ 0.07 (Hu & Bentler, 1999).

Modification indices indicated that model fit would be improved by permitting covariance between sets of error terms falling within similar dimensions (BH3 with BH1 and BH2; CA4 with CA3) ($\Delta\chi^2$ =82.58). Our final measurement model provided evidence of adequate model fit (χ^2 = 1122.35, *df* = 139, RMSEA = 0.08, CFI = 0.94, NNFI = 0.93, SRMR = 0.04). See Table 1 for fully standardized factor loadings, *t*-values, measure of internal consistency, and descriptive statistics for items. Pearson's

correlation coefficient indicated significant correlations between normative belief scale items and social comparison items (Table 2, 3).

Table 9. Bivariate correlations among descriptive and injunctive beliefs items.

	DB1	DB2	DB3	DB4	IB1	IB2	IB3	IB4
DB1	—							
DB2	.77	—						
DB3	.74	.62	—					
DB4	.70	.66	.69	—				
IB1	.36	.33	.32	.29	—			
IB2	.33	.40	.27	.28	.87	—		
IB3	.34	.30	.38	.28	.86	.77	—	
IB4	.35	.37	.31	.40	.79	.82	.77	—

Note. All correlations significant at the 0.01 level (2-tailed).

Table 10. Bivariate correlations among self-monitoring and concern for appropriateness items.

	SM1	SM2	SM3	SM4	CA1	CA2	CA3	CA4
SM1	—							
SM2	.41	—						
SM3	.50	.35	—					
SM4	.45	.39	.42	—				
CA1	.37	.37	.32	.23	—			
CA2	.50	.31	.45	.28	.33	—		
CA3	.36	.29	.41	.21	.29	.53	—	
CA4	.35	.23	.37	.15	.23	.50	.57	—

Note. All correlations significant at the 0.01 level (2-tailed).

Next, we proceeded with estimation of a structural model. These results provided evidence of adequate fit between sample data and the hypothesized structural

relationships (χ^2 = 1122.59, *df* = 139, RMSEA = 0.08, CFI = 0.94, NNFI = 0.93, SRMR = 0.04) (Table 4). Our findings illustrate that descriptive beliefs had a positive and significant direct effect on self-reported AIS mitigation behavior, supporting H1a (β = 0.25, *t* = 6.19***). Concern for appropriateness had a negative direct effect on self-reported behavior, thus, H4 was rejected (β = -0.20, *t* = -2.99**). Together, these factors accounted for 8% of the variance on behavior. Injunctive beliefs had a positive and significant direct effect on self-monitoring (β = 0.13, *t* = 2.94**) and concern for appropriateness (β = 0.15, *t* = 3.43***), supporting H2b and H2, but only accounted for 1% and 2% of the variance, respectively (Table 4). The hypothesized direct effects of injunctive beliefs (H2a) and self-monitoring (H3) on self-reported behavior were rejected, as were the direct effects of descriptive beliefs on self-monitoring (H5) and concern for appropriateness (H6). With regards to indirect effects, paths from descriptive beliefs through self-monitoring (Sobel = 0.48) and concern for appropriateness (Sobel = 0.94) were not statistically significant. The path from injunctive beliefs through self-monitoring (Sobel = 1.41) was not statistically significant but the path through concern for appropriateness was statistically significant (Sobel = -2.27**). The total indirect effect of descriptive beliefs (H7; *t* = 0.08) and injunctive beliefs (H8; *t* = -1.73) on behavior, however, were not statistically significant (Table 4).

Table 11. Summary results of structural model.

Direct effects	λ	β	*t*	SE	R^2
Descriptive belief (DB) → AIS behavior (BH) (H1a)***	—	0.25	6.19	0.04	0.08
Injunctive belief (IB) → AIS behavior (H2a)	—	0.01	0.32	0.04	
Self-monitoring (SM) → AIS behavior (H3)	—	0.11	1.57	0.07	
Concern for appropriateness (CA) → AIS behavior (H4)**	—	-0.20	-2.99	0.07	
Descriptive belief → self-monitoring (H1b)	-0.02	—	-0.05	0.04	0.01
Injunctive beliefs → self-monitoring (H2b)**	0.13	—	2.94	0.04	
Descriptive beliefs → concern for appropriateness (H1c)	-0.04	—	-0.93	0.04	0.02
Injunctive beliefs → concern for appropriateness (H2c)***	0.15	—	3.43	0.04	

Indirect effects	β	*t*	SE
Descriptive belief → AIS behavior (H5)	<0.00	0.80	0.01
Injunctive belief → AIS behavior (H6)	-0.02	-1.73	0.01

Goodness-of-fit indices: χ^2 = 1122.59, *df* = 139, RMSEA = 0.08, CFI = 0.94, NNFI = 0.93, SRMR = 0.04

*p < 0.05, **p < 0.01, ***p<0.001

Discussion

The purpose of this study was to examine the relationships among normative social beliefs, social comparison processes, and self-reported behavior in an applied natural resource setting. Confirmatory factor analyses indicated adequate performance of items and scales based on the model fit, strength of factor loadings, and reliability estimates. Path analysis revealed an adequate fit between sample data and the hypothesized structural relationships among latent constructs. Findings support the hypothesized relationship between descriptive beliefs and self-reported behavior but not injunctive beliefs. Results support the hypothesized relationships between injunctive

beliefs and both self-monitoring and concern for appropriateness. These findings also indicate that concern for appropriateness has a significant direct effect on self-reported behavior but, in contrast to our hypothesis, this relationship was negative. Our findings do not support the hypothesized relationship between descriptive beliefs and self-monitoring and concern for appropriateness, nor self-monitoring and self-reported behavior. No evidence of mediation was observed. Though sample size was relatively large, the observed beta weights of statistically significant relationships were low, as was variance explained by significant effects.

Consistent with our hypothesis, descriptive beliefs were observed to have a significant positive relationship with self-reported behavior. Previous research has demonstrated that beliefs about what others do is predictive of an individual's decision to engage in the associated behavior (e.g., Berkowitz & Perkins, 1986; Cialdini, 2003; Nolan, 2008). Similar to Cialdini's (2007) and others' contention (e.g., Miller & Prentice, 2016; Newell et al., 2014), these results highlight how beliefs about other's behavior influence an individual's decision to engage in behaviors that mitigate negative environmental impacts. Our results imply AIS management may benefit from increasing the boater's beliefs that others boaters engage in AIS mitigation behaviors, i.e., facilitate the salience of social proof.

Inconsistent with our hypotheses, the relationship between descriptive beliefs and self-monitoring and concern for appropriateness were not significant (consequently, no significant mediation of the belief-behavior process was observed). In contrast, the observed relationship between injunctive beliefs and both self-monitoring and concern

for appropriateness was significant. These findings suggest holding a belief that others deem a behavior appropriate is related to a tendency to concern oneself with how appropriate others perceive a behavior to be. Moreover, an individual tends to compare their behavior and monitor others' responses to their behavior in an attempt to assess the likelihood of incurring social (dis)approval (Abrahamse & Steg, 2013; McKenzie-Mohr & Schultz, 2014; Schultz et al., 2008). The significant paths from injunctive beliefs to both self-monitoring and concern for appropriateness align with past work suggesting injunctive beliefs are related to increased cognitive deliberation, particularly in comparison to descriptive beliefs (Kredentser et al., 2012; Melnyk et al., 2011; Schultz et al., 2014). As Cialdini (2003) suggests, findings that highlight the two dimensions of normative social beliefs operating differently, such as ours, affirm the distinct theoretical nature of descriptive and injunctive beliefs. Our study sought to provide additional evidence of this distinct relationship and potential mediating factors. However, our analysis does not provide evidence of the belief-behavior relationship being mediated by our measures of social comparison. Given past research suggests descriptive and injunctive beliefs influence behavior via different cognitive pathways, with injunctive beliefs conceptualized as indirectly influencing behavior and increasing cognitive deliberation (e.g., Schultz et al., 2014), further research on these distinct pathways is warranted.

Contrary to our hypothesis, though significant, the relationship between concern for appropriateness and behavior was observed to be negative. That is, individuals reporting more concern related to the perceived appropriateness of CDD behaviors

engage in fewer of the associated behaviors. These results may be explained in terms of self-efficacy or ambivalence (Byg, Martin-Ortega, Glenk, & Novo, 2017; Fishbein & Ajzen, 2011). **W**hile concerned with engaging in socially appropriate AIS mitigation behaviors, boaters may not believe they are capable of completing AIS mitigation tasks adequately or effectively. For instance, a boat ramp setting can be crowded and not provide space conducive to cleaning and draining, or boaters may not feel they are capable of adequately doing AIS mitigation behaviors after a day of boating. Ambivalence may also explain the negative relationship, as boaters, though concerned with socially appropriate behavior, may feel that no matter what AIS mitigation behaviors they engage in it will not reduce AIS spread. The relationship between self-monitoring and behavior was not significant. These results may be explained in terms of self-monitoring being defined as both monitoring others behavior and their reaction to one's own behavior, implying a range of cognitive deliberation, which may not have been activated in this particular study context (Bandura, Grusec, & Menlove, 1967; Kredentser et al., 2012), as AIS mitigation behaviors may vary in terms of their execution in public or private settings (i.e., boaters can choose to do them at the boat ramp or at home).

In general, our results align with past studies, which observe mixed results in terms of the influence self-monitoring has on behavior (Jang 2012; White et al., 2009; Yun & Silk, 2011). While much of this past research conceptualized self-monitoring as a moderator, this study asked *how* and *why* do normative social beliefs and social comparison affect behavior, as opposed to *when*. That is, we conceptualized social cues

related to others' behavior and subsequent salience of normative social beliefs as "external physical events" that have "internal psychological significance", i.e., they trigger social comparison tendencies (Baron & Kenny, 1986, p. 1176). We also anticipated self-monitoring and concern for appropriateness to add to the overall variance accounted for our model of the belief-behavior process (rather than levels of social comparison, e.g., low and high self-monitors, specify conditions under which normative social beliefs predict self-reported behavior). However, our results do not provide evidence of self-monitoring adding to the variance explained by the model. In addition to conceptualizing self-monitoring as a mediator, our study included measures of injunctive beliefs and concern for appropriateness, which have limited inclusion in past studies. As evidenced by the significant paths between injunctive beliefs and concern for appropriateness and self-monitoring, and concern for appropriateness and behavior, their inclusion is useful, both theoretically and empirically. The inclusion of a measure perceptions of a behaviors social approval (injunctive beliefs) and a measure of an individual's tendency to avoid social disapproval (concern for appropriateness) provide insights into how and why an individual chooses based on social context. While our results were mixed, these measures, in conjunction with descriptive beliefs and self-monitoring, represent an area of social-cognitive elements of resource-users' responses to perceptions of social context and responses to those perceptions.

Conclusion

Results from our measurement and structural models indicate good fit between the data and the hypothesized relationships. However, the explanatory power of our model was weak. This suggests a need to refine the conceptualization or operationalization of social comparison constructs or include additional explanatory variables, such as self-efficacy or personal norms, may be needed. That is, an individual's decision to engage in AIS mitigation behaviors also involves aspects of, for example, their awareness of the risk posed by AIS, belief that behaviors mitigate AIS spread, and ability to conduct effective AIS mitigation behaviors. Further research may also examine the contention that descriptive and injunctive beliefs operate in a dual processing manner, with descriptive beliefs directly influencing behavior and injunctive beliefs indirect influence relying of social comparison deliberation. In conclusion, while findings were mixed, collectively, this study adds to a growing body of literature examining the relationship between normative social beliefs and behavior in applied settings, with the addition of social comparison measures, to understand the relationship between social context and social-cognitive processes.

5. CONCLUSIONS

This doctoral dissertation employed survey research methods to examine licensed Texas boaters' perceptions and behaviors related to AIS and CDD, focusing on normative social aspects on behavior and decision-making. The objective of Chapter II was to incorporate the theoretical and definitional refinement of FT into SCA and the RPM by measuring injunctive (approval) and descriptive (commonness) normative beliefs across a single behavior dimension. In general, results reveal a single-tolerance injunctive normative standard for Texas boaters—to perform all AIS mitigation behaviors every time they boat—as this single behavior represents both the point of maximum return and range of tolerable behavior. This is in contrast to the observed descriptive normative standard across the same behavior dimension, which indicates boaters perceive various levels of AIS mitigation behaviors as likely to occur as not, as indicated by an indeterminate RTB and PMR. Further calculations and analysis of norm metrics also indicate significant difference between intensity, normative power, and potential return difference across models. These results highlight injunctive and descriptive normative beliefs and the corresponding perceived social norm manifest with distinct structures and characteristics within the same behavior dimension and social-environmental context, demonstrating the usefulness of an extended RPM to illustrate those differences (or similarities).

The purpose of Chapter III was to examine how different message frames affect boaters' intention to engage in AIS mitigation behaviors, specifically those related to

CDD in Texas. Our results add to calls for increased human-centered biological invasion research and builds upon applied research demonstrating variation in the effectiveness of message framing and associated trends toward replication (Lakoff 2010; McLeod et al. 2015; Open Science Collaboration 2015; Scheibehenne et al. 2016). Overall, our main analysis revealed significant differences among message conditions while controlling for personal norms. Consistent with H2, participants receiving a regulatory message report significantly different and higher levels of intention in comparison to the information-only condition. Participants receiving messages with descriptive and injunctive information did not differ significantly from one another, which aligns with H3. Concerning H1, participants receiving messages framed with normative social information did not report significantly different intentions, which is, generally, inconsistent with predictions from theory but aligns with past studies observing mixed results of messages framed with normative social information in applied settings.

The purpose of Chapter IV was to examine the relationships among normative social beliefs, social comparison processes, and self-reported behavior in an applied natural resource setting. Confirmatory factor analyses indicated adequate performance of items and scales based on the model fit, strength of factor loadings, and reliability estimates. Path analysis revealed an adequate fit between sample data and the hypothesized structural relationships among latent constructs. Findings support the hypothesized relationship between descriptive beliefs and self-reported behavior but not injunctive beliefs. Results support the hypothesized relationships between injunctive beliefs and both self-monitoring and concern for appropriateness. These findings also

indicate that concern for appropriateness has a significant direct effect on self-reported behavior but, in contrast to our hypothesis, this relationship was negative. Our findings do not support the hypothesized relationship between descriptive beliefs and self-monitoring and concern for appropriateness, nor self-monitoring and self-reported behavior. No evidence of mediation was observed. Though sample size was relatively large, the observed beta weights of statistically significant relationships were low, as was variance explained by significant effects.

The primary three chapters presented in this dissertation build on the environmental and conservation psychology literature pertaining to normative social influences on behavior and individual decision-making. These studies also adds to a growing body of applied research literature focused on invasives species management. Collectively, insights from these three studies have implications for practice and theory. For theory, findings have direct implications for the plausibility of theoretical tenets pertaining to (a) how descriptive and injunctive beliefs create and structure perceived social norms, (b) the scope condition under which different message frames, including descriptive and injunctive normative social information, affect or do not affect behavior, and (c) the relationship between normative social beliefs, social comparison processes (self-monitoring and concern for appropriateness), and behavior. For practice, findings provide managers with potential avenues to influence or facilitate behaviors that result in desired outcomes by highlighting (a) perceptions of social proof and social approval related to clean, drain, and dry behaviors, (b) influential message frames that can influence a boater's intention to engage in AIS mitigation, (c) and the process by which

boaters choose to engage in AIS mitigation from a normative perspective, providing practitioners with potential methods to influence or facilitate behaviors that result in desired outcomes.

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